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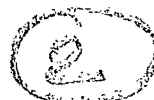
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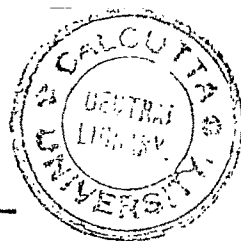
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Geographic Flows of Hired Agricultural Labor: 1957-1960*

LOWELL E. GALLAWAY

Data obtained from Social Security Administration records are used to examine whether hired agricultural labor moving from one census region to another within the United States is responsive to economic phenomena. The unique feature of the analysis is its access to data describing gross flows of hired agricultural labor among these regions rather than having to rely on observations of net changes in the quantity of such labor. The general conclusion is that hired agricultural workers are responsive to economic phenomena in the directions suggested by formal economic theory but that inter-regional movement of such workers is greatly hampered by the presence of artificial barriers to mobility.

IN A recent article in this journal [4], I explored patterns of inter-industry movement of hired agricultural labor from 1957 to 1960. The source of data for that article was a 1-percent sample of the records maintained by the Social Security Administration in the course of administering the Old Age Survivors Disability and Health Insurance (OASDHI) system. From that sample, the movement of hired agricultural workers between broad industry groups was analyzed. The same sample also provides information on the geographic location of employment of hired agricultural labor. Specifically, workers employed as hired agricultural laborers in 1957 who were also employed in some industry¹ in 1960 can be located in one of nine broad census regions in both of these years.² These data are available by sex and age and it can be determined whether the workers in question remained in agricultural employment. Also, information on 1960 earnings is available for each mobility observation.³ Using the information on male members of this sample of workers, I will attempt to test certain hypotheses which might be advanced to explain the nature of interregional flows of hired agricultural labor.⁴

Recent Investigations of Geographic Mobility of Agricultural Labor

A number of recent studies have been devoted to analyzing the labor market for hired agricultural labor. At the national level, the work of Johnson and Heady [8] and Schuh [11] should be noted; at the regional level,

* The data for this article are a by-product of a more inclusive study of geographic mobility patterns being conducted under the auspices of the Social Security Administration. Of course, the conclusions expressed here do not necessarily reflect an official position of the Social Security Administration. All calculations were carried out at the University of Pennsylvania Computer Center.

¹ As used here, the term *industry* denotes one of the following broad industrial categories: Agriculture; Mining; Contract Construction; Durable Goods Manufacturing; Nondurable

Schuh and Leeds [12], Tyrczniewicz and Schuh [15], and Diehl [3] have made contributions. The first four of these estimate the structural parameters of either demand or supply relationships for hired agricultural labor through the use of time-series data. Thus, they are dealing essentially with net changes in the employment of hired agricultural labor, as is Diehl, who presents a migration model to explain net farm-to-nonfarm population migration. The same is true for such earlier investigations of regional movements of agricultural resources as Bachmura [1] and Bishop [2].⁵

The need for relying on net mobility data has made the researcher's task more difficult.⁶ Fortunately, the data available through the sample described earlier provides longitudinal information of a gross-flow type. In fact, the unique feature of this discussion is its access to gross-flow data—data which permit the further testing of some of the conclusions which have emerged from the previous investigations of the market for hired agricultural labor. While this is all to the good, it should be noted that the data available have certain shortcomings. First, the sample is not complete in that workers who were not in employment covered by the OASDHI system in either 1957 or 1960 are not included. Consequently, it is not possible to explore movements between the agricultural sector and the category "not in the labor force." Second, there may be some question as to whether all hired farm employment (particularly "casual" labor) is reported under the Social Security system. Third, the amount of information relating to the personal characteristics of workers in the sample is somewhat limited. In addition to industry, region of employment, and earnings, only age, race, and sex are noted. Finally, it is by no means clear that the time period encompassed by the sample data is a typical one. The 1957–1960 interval coincides roughly with the last full peak-to-peak business cycle in the United States and was selected in an attempt to minimize the impact of variations in the general level of economic activity on the phenomena under

Goods Manufacturing; Transportation, Communications, and Public Utilities; Wholesale and Retail Trade; Finance, Insurance, and Real Estate; Services; and Government. A worker is considered to be employed in the industry in which he receives the greatest amount of earnings in the year in question.

² The nine regions are New England, Middle Atlantic, South Atlantic, East North Central, East South Central, West North Central, West South Central, Mountain, and Pacific. As was the case in assigning workers to an industry, a worker is considered to be employed in the region in which he receives the largest amount of earnings in a given year.

³ The earnings data are estimated earnings. Earnings for some workers must be estimated because of the existence of a taxable maximum on earnings covered by the OASDHI program. For a description of the estimation process, see my recent report [5, pp. 323–325].

⁴ The movement of female workers was not considered in this analysis because their geographic movement is frequently "tied" to that of males through marital relationships.

⁵ The Bachmura and Bishop studies emphasize the question of the returns to human resources employed in agriculture. This is also true at a more aggregative level of Hathaway [7].

⁶ For example, reliance on net mobility data frequently necessitates the use of time-series information, a procedure which creates problems in using standard estimation techniques. For insight into some of these problems, see Tyrczniewicz and Schuh [15, pp. 548–549].

consideration. However, since unemployment over the full course of that cycle was the highest observed in the post-World War II period,⁷ it may well be that the period is somewhat atypical. Some instances in which this may be important will be noted in the discussion which follows.

The Theoretical Framework

The basic theoretical framework for exploring the gross interregional flows of hired agricultural labor is that suggested by conventional economic theory. Our principal focus will be on the supply of such labor, and formal theory argues that the quantity of labor which a worker supplies to the market is determined by his equating the wage rate in the market with his marginal rate of substitution between income and leisure. From this, it follows that when workers consider several alternative markets simultaneously, they will offer their labor services in that market where the wage rate is highest *once* various costs of movement are taken into consideration.⁸ In the case of regional markets, we can formalize the conditions which determine the supply of labor as follows⁹:

$$(1) \quad S_j = S_o + \sum_{i=1}^n (S_{ij}),$$

$$(2) \quad S_o = f(w_j, C_j),$$

and

$$(3) \quad S_{ij} = \phi(w_j, C_j),$$

where

S_j is the supply of labor in the j th region,

S_o is the quantity of labor supplied to the j th region by itself, that is, labor which remains in the region from the preceding time period,

S_{ij} is the flow of labor into the j th region from the i th region,

w_j is the wage rate in the j th region, and

C_j represents the costs of employment (both objective and subjective) in the j th region.

Expressions (2) and (3) can be developed further by considering specific

⁷ The average national unemployment rate over the course of the 1957-1960 business cycle was 5.9 percent as contrasted to 4.2 percent for the 1948-1953 cycle and 4.4 percent for the 1953-1957 period. Certainly, the average unemployment rate over the full course of the present business cycle will be markedly less than 5.9 percent.

⁸ A fuller discussion of the theoretical foundations of the mobility process is contained in my earlier study [4].

⁹ An alternative to focusing specifically on the supply side of the market is the specification of a simultaneous equations model of the market. This is particularly useful whenever net-flow data must be used. However, given the availability of gross-flow data in this study, I decided to concentrate on the supply side of the market. As these expressions are expanded, a demand variable will be included in some cases.

factors which might impose costs of employment (including movement costs) on workers. For example, an obvious source of such costs would be the distance between regions. It would seem that a greater distance between regions not only would involve more substantial money costs of movement¹⁰ but also would increase the "search" costs involved in locating new employment, that is, the expenditure of time and effort necessary to overcome the barriers to the flow of labor market information between areas.¹¹ Thus, distance between regions can be included explicitly in (3) but not in (2) since that expression deals exclusively with workers who do not move between regions.¹²

Another source of possible movement costs is the complex of social and personal ties that an individual may have to a particular region. Although these do not impose money costs of movement, they exact a toll in terms of psychological costs and these do have some monetary equivalent.¹³ For the most part, it could probably be assumed that such costs are similar across all regions and thus could be ignored. However, they are not similar across *age* groups, and consequently any analysis which takes into consideration differences in age-group mobility can usefully incorporate some type of age variable.¹⁴ Such a variable would have an impact on the dependent variable of both expressions (2) and (3).

In addition to considering factors which impose employment costs on workers, we should also include variables which might either reduce these costs or help to finance them. A possibility in the first case, for example, is the number of jobs available to workers in various areas. Presumably, the greater the number of such jobs, the more likely it is that workers will have information about their existence and the lower will be the "search" costs mentioned earlier.¹⁵ Such a variable would have an impact on both expressions (2) and (3). From the standpoint of the ability of workers to bear the costs of movement, some variable that measures the asset position of work-

¹⁰ For a discussion of some aspects of the pure money costs of movement, see Maddox [9].

¹¹ Good discussions of the costs of search are contained in Stigler [13 and 14].

¹² If one wished to include a distance variable in expression (2), it would have to be a measure of relative "remoteness" from other regions. One possibility is simply the average distance to all other regions. However, in the empirical analysis such a variable did not perform well, and consequently it is omitted from these formulations.

¹³ The monetary equivalent of a psychological cost is the additional amount of money income which would just be sufficient to neutralize its effect on the decision-making process.

¹⁴ The age variable might possibly also measure the impact of seniority systems on the mobility decision, particularly when farm-to-nonfarm mobility is considered. However, in farm-to-farm mobility, seniority provisions are probably of little significance.

¹⁵ A standard thesis in much labor mobility literature is that "job opportunity" is the primary consideration in explaining mobility patterns. Job opportunity is interpreted also as taking into account the distance between jobs. Frequently, job opportunity is offered as an alternative to the formal economic theory of labor mobility. For an excellent review of this dichotomization of mobility literature, see Raimon [10]. Obviously, from what has been said to this point, there is no major conflict between "job opportunity" and the maximizing hypothesis that is the cornerstone of the formal theory.

ers would be quite useful. One possibility is the worker's position in the life cycle of earnings. Young workers with relatively low earnings probably have a poorer asset position than older workers with higher earnings. Consequently, the average earnings of the worker's age group may serve very well as a measure of his relative asset position. Use of this measure would suggest that the higher the earnings level of workers in this age group, the greater the mobility of that group. However, there is some ambiguity involved in this line of reasoning. It could be argued that the higher the earnings of an age group, the greater the risk involved in moving and, therefore, the less likely workers would be to move, because of the additional cost implicit in their accepting greater risk.¹⁶ Consequently, it is not clear on *a priori* grounds what the relationship between age-group earnings and interregional mobility should be.¹⁷

On the basis of the foregoing discussion, expressions (2) and (3) can be expanded as follows:

$$(4) \quad S_{\bullet} = f(w_j, A, E_a, O_j)$$

and

$$(5) \quad S_{ij} = \phi(w_j, D_{ij}, A, E_a, O_j),$$

where

A indicates the age of a worker,

E_a is the age-group earnings level,

O_j is the number of jobs available to workers in the j th region, and

D_{ij} is the distance between the i th and j th regions.

Further, the following partial derivatives can be posited on an *a priori* basis:

$$(4a) \quad \frac{\partial S_{\bullet}}{\partial w_j} > 0, \quad \frac{\partial S_{\bullet}}{\partial A} > 0, \quad \frac{\partial S_{\bullet}}{\partial E_a} \geq 0, \quad \frac{\partial S_{\bullet}}{\partial O_j} > 0,$$

and

$$(5a) \quad \frac{\partial S_{ij}}{\partial w_j} > 0, \quad \frac{\partial S_{ij}}{\partial A} < 0, \quad \frac{\partial S_{ij}}{\partial E_a} \geq 0, \quad \frac{\partial S_{ij}}{\partial D_{ij}} < 0, \quad \text{and} \quad \frac{\partial S_{ij}}{\partial O_j} > 0.$$

Empirical Results

The theoretical discussion of interregional labor flows suggests a straightforward method of testing empirically the hypotheses presented in the dis-

¹⁶ It is assumed that workers are risk averters.

¹⁷ For example, in a recently published study of interindustry job changing [5], I found that the age-group earnings variable was strongly significant in one direction. On the other hand, in a study of geographic mobility in general, I found it to be significant in the other direction. The geographic mobility results are contained in an unpublished manuscript entitled "Geographic Labor Mobility in the United States: 1957-1960."

cussion. For example, the relationships denoted in expression (4) can be embodied in a least-squares regression of the form

$$(4b) \quad S_o = a + bw_j + cA + dE_o + eO_j + u,$$

where u denotes a random error term. Such a regression can be estimated from the data at our disposal. Specifically, S_o can be expressed as the percentage of hired agricultural workers employed in a region in 1957 who were also employed in that region in 1960. This information is presented in Table 1 for two groups of workers—those whose industry of major job was agriculture in both 1957 and 1960 and those whose industry of major job was not in agriculture in 1960. As can be seen, these data are available for nine regions and three different age groups (less than 25, 25–39, and 40 and over).

Table 1. Percentage of workers with same region of major job in both 1957 and 1960, by region, industry change, and age

Region	Same industry of major job in 1957 and 1960			Different industry of major job in 1957 and 1960		
	Age less than 25	Age 25–39	Age 40 and over	Age less than 25	Age 25–39	Age 40 and over
	percent					
New England	100.00	91.67	98.50	90.91	80.00	94.52
Middle Atlantic	98.04	95.15	94.96	86.61	77.60	78.49
South Atlantic	92.52	94.29	95.28	85.19	79.62	90.12
East North Central	96.43	95.45	95.13	86.86	73.02	74.77
East South Central	92.73	95.93	98.71	68.85	75.28	84.34
West North Central	88.89	95.77	96.94	86.23	83.74	95.24
West South Central	93.75	92.38	95.79	82.47	78.86	90.54
Mountain	89.80	88.03	90.83	78.49	78.57	75.00
Pacific	97.78	93.26	96.29	88.38	85.09	88.57

Source: Social Security Administration, 1-percent Continuous Work History Sample

The earnings variable, w_j , is simply mean earnings of workers in the various regions. Two separate sets of earnings estimates are used. One consists of 1960 earnings of all workers in the various regions. It is designed to be used in connection with the S_o data for workers who changed industry of major job between 1957 and 1960. The second consists of 1957 regional earnings levels of all hired agricultural workers and is designed to be used whenever the dependent variable in the regression refers only to workers employed in agriculture in both 1957 and 1960. Earnings for 1960 could not be used in this instance because the industry of employment in 1960 of workers who changed industry of major job is not known by region.¹⁸

Age, A , is handled in expression (4b) by assigning the numerical values

¹⁸ The data are tabulated so that the only information available about industry of employment in 1960 by region is whether it is the same as that in 1957. It is for this reason that 1960 earnings information by region for all workers employed as hired agricultural laborers is not available.

one, two, and three to the three age groups in ascending order. Thus, the less-than-25 age group has a value of one, 25-39 a value of two, and 40-and-over a value of three. The age-earnings variable, E_a , is simply mean 1957 earnings by age group for workers in the various regions. Finally, the number-of-jobs variable (really, a labor-demand variable), O_j , consists of the number of hired agricultural workers employed in different regions in 1957. This variable is only used in conjunction with the analysis of the behavior of workers employed in agriculture in both 1957 and 1960.¹⁹

As can be gathered from the discussion of the nature of the data and the variables used, two different regressions of the form shown in (4b) were estimated—one for workers who changed industry of major job between 1957 and 1960 and the other for workers who remained in agriculture. The former is denoted by the second subscript c and the latter by the second subscript s . Thus, two different aspects of the supply of hired agricultural labor are analyzed. The results of the estimation process are²⁰

$$(4c) \quad S_{oc} = 68.0083 + 0.0032w_j + 4.014A - 0.0055E_a \quad (R^2 = 0.00)$$

(1.2311) (1.5765) (1.5272)

and

$$(4d) \quad S_{os} = 81.8138 + 0.0077w_j + 2.938A - 0.0041E_a - 0.0003O_j$$

(3.1547) (2.8810) (2.7712) (0.2616)

($R^2 = 0.25$)

The two regressions yield quite different results. That for workers who moved out of agriculture between 1957 and 1960 shows very weak relationships (although with the expected signs) between the independent and dependent variables, and when the R^2 is corrected for degrees of freedom it is equal to zero. Consequently, the hypotheses advanced in the theoretical discussion as to how hired agricultural workers behave in the labor market receive little support from this evidence. On the other hand, the regression for workers who remained in agriculture shows significant relationships between the proportion of stayers and the regional earnings, age, and age-group earnings variables.²¹ Only the number-of-workers variable, O_j , is not

¹⁹ It is somewhat more difficult to structure a demand variable for workers who changed industry of major job because we have no information about the 1960 distribution of workers across industries. Consequently, no such variable is included in the analysis.

²⁰ The regression equations are presented with the t -values shown in parentheses below the respective coefficients. R^2 's are corrected for degrees of freedom. For certain purposes, the elasticities associated with the various coefficients are useful. In those cases where the regression coefficients are significant at the 5-percent level, they were estimated at the means. For regression (4d), the elasticities are +0.14 for the wage variable, +0.06 for the age variable, and -0.07 for the age-earnings variable.

²¹ Since the signs of the variables are hypothesized *a priori*, one-tailed significance tests are used except for the age-group earnings variable whose sign was not posited beforehand. On this basis, the earnings and age variables are significant at the 0.5-percent level and the age-group earnings variable is significant at the 2-percent level.

significant, and consequently the regression was re-estimated without this variable:

$$(4e) \quad S_{ss} = 81.7364 + 0.0076w_j + 2.923A - 0.0040E_a \quad (R^2 = 0.26). \\ (3.2368) \quad (2.9307) \quad (2.8172)$$

Because of the extra degree of freedom gained through the exclusion of the number-of-workers variable, the proportion of explained variance (adjusted for degrees of freedom) actually increases by one percentage point and the *t*-values for all three independent variables are higher.²² Thus, the results are consistent with the hypotheses previously advanced, although less than 30 percent of the variance is explained. Of particular interest is the negative sign of the age-group earnings variable, which indicates that higher age-group earnings contribute to increasing the propensity to move inter-regionally of hired agricultural workers who were employed in agriculture in both 1957 and 1960. This propensity probably reflects the fact that these earnings are related positively to the financial ability of workers to bear the costs implicit in a geographic relocation.

While the results shown in (4c), (4d), and (4e) are interesting, they tell only a part of the story of geographic mobility patterns of hired agricultural labor. Perhaps the most significant aspect of such flows is the actual movements of workers between regions. The theoretical relationships we have hypothesized are embodied in expressions (5) and (5a) which suggest a least-squares regression of the form

$$(5b) \quad S_{ij} = a + bw_j + cD_{ij} + dA + eE_a + fO_j + u.$$

The distance variable, D_{ij} , in this regression roughly measures the number of regional boundaries which a worker must cross in order to reach his destination.²³ The variable has a range of one to six, with six representing the distance between the New England and Pacific regions. The full set of distance variables is shown in Table 2. The dependent variable, S_{ij} , is expressed in terms of actual numbers of workers moving between regions

²² The significance of the age-group earnings variable is increased to the 1-percent level. Overall, the regression equation is significant at the 0.1-percent level. The elasticities change slightly to +0.13 for the wage variable, +0.06 for the age variable, and -0.06 for the age-earnings variable.

²³ It could be argued that the distance variable is something of an oversimplification, particularly in that the regions in the Far West are larger and thus the distance variable used here is not strictly proportional to the actual distance between regions. However, there is probably not much distortion from this. Several forms of the distance variable were tried in various regressions. In particular, when the square of the distance variable was used the results were poorer. Further, when a quadratic form including both the present distance variable and its square was estimated, in those cases where the square of the distance variable was significant it had a negative sign suggesting, if anything, that the distance variable used here overstates the impact of distance when the distance variable is relatively large. However, the quadratic term generally was not particularly significant, either statistically or quantitatively.

Table 2. Distance variables (D_{ij}) used in regression analysis of hired agricultural labor mobility

Region of origin	Region of destination ^a								
	NE	MA	SA	ENC	ESC	WNC	WSC	M	P
New England (NE)	—	1	2	2	3	3	4	5	6
Middle Atlantic (MA)	1	—	1	1	2	2	3	4	5
South Atlantic (SA)	2	1	—	1	1	2	2	3	4
East North Central (ENC)	2	1	1	—	1	1	2	2	3
East South Central (ESC)	3	2	1	1	—	2	1	2	3
West North Central (WNC)	3	2	2	1	2	—	1	1	2
West South Central (WSC)	4	3	2	2	1	1	—	1	2
Mountain (M)	5	4	3	2	2	1	1	—	1
Pacific (P)	6	5	4	3	3	2	2	1	—

^a The distance variable is expressed in terms of roughly the number of regional boundaries a worker must cross in order to move from one region to another.

rather than in percentage form as was the S_o variable in (4b). This necessitates inserting one additional variable into (5b), namely, a scale variable designed to take account of differences in the number of hired agricultural workers in the various regions.²⁴ This variable is designated by the symbol P_j . With the addition of this variable, the following regressions were estimated:

$$\begin{aligned}
 (5c) \quad S_{ijc} = & 2.2110 + 0.0007w_j - 1.3400D_{ij} - 1.6700A \\
 & (2.1312) \quad (9.1085) \quad (4.4759) \\
 & + 0.0017E_a + 0.0035P_j \quad (R^2 = 0.29), \\
 & (3.8000) \quad (3.1784)
 \end{aligned}$$

and

$$\begin{aligned}
 (5d) \quad S_{ijs} = & -1.8460 + 0.0011w_j - 0.8300D_{ij} - 0.4400A \\
 & (1.8238) \quad (6.8912) \quad (1.5069) \\
 & + 0.0008E_a + 0.0014O_j + 0.0047P_j \quad (R^2 = 0.30). \\
 & (2.3013) \quad (4.1705) \quad (5.5084)
 \end{aligned}$$

These results basically confirm the hypotheses suggested in the theoretical discussion of mobility. In expression (5c), all of the independent variables are significant.²⁵ In addition, in those cases in which the signs of the variables

²⁴ The scale variable is simply the total number of agricultural workers who left a region between 1957 and 1960. Thus, it is $\sum_{j=1}^n S_{ij}$, and its addition, in effect, converts the gross-flow data into percentage form.

²⁵ Using one-tailed tests for all variables except age-group earnings, we find earnings significant at the 2.5-percent level, distance and age significant at the 0.05-percent level, scale significant at the 0.5-percent level, and age earnings significant at the 1-percent level. The

were posited on an *a priori* basis, the results conform to our expectations. In the only case in which the signs were not so posited (the age-earnings variable), the results indicate that the greater the age-group earnings of workers, the more mobile the workers are. This is in agreement with our earlier findings and supports the thesis that high age-group earnings may indicate a stronger asset position and a greater financial capacity to bear the costs of movement.

Perhaps the most perplexing aspect of regression (5c) is the conflict between it and the results shown in (4c). There, none of the independent variables were significant at an acceptable level. This fact suggests that hired agricultural workers who change their industry of major job behave in accordance with formal economic theory when moving between geographic regions but not when deciding whether to stay in the area in which they have been employed. A possible explanation for this anomaly may be (1) that barriers to farm-nonfarm mobility of workers operate to restrict the job choice of workers moving out of agriculture and (2) that these barriers are greater in high-wage regions.²⁶ Such a combination of circumstances could have the result that workers in high-wage regions who leave agriculture are more strongly affected by the farm-nonfarm mobility barriers than workers in low-wage regions. This result would account for the weakness of the regional-earnings variable in regression (4c). At the same time, the impact of such barriers on the actual gross flows of workers might be reduced by workers' not having accurate perceptions of their strength in other regions. While this is a somewhat speculative explanation for the observed discrepancy in the regression results, there are some fairly convincing arguments to suggest that it may be a valid one. For one thing, on *a priori* grounds it is not unreasonable to argue that barriers to farm-nonfarm mobility are greater in high-wage regions. Trade unions and formal seniority systems, which are probably major sources of farm-nonfarm mobility barriers, tend to have a stronger impact in the high-wage areas, which are generally more industrialized. Consequently, workers who leave agriculture in these regions may encounter high farm-to-nonfarm barriers to finding another job. If so, we might expect that agricultural workers moving from high-wage areas to low-wage areas are more likely to change to nonagricultural work than workers moving from low-wage to high-wage areas. This is what actually happens. In the five regions with 1960 mean earnings below the mean for all workers, 63 percent of those who moved interregionally also changed industry of major job. The comparable figure

elasticity of the wage variable is +1.30, of the distance variable is -1.21, of the age variable is -1.32, and of the age-group earnings variable is +1.01.

²⁶ On *a priori* grounds this explanation is not unreasonable. Unions and formal seniority systems are probably more prevalent in the high-wage areas, which are generally more industrialized, and these are quite likely to be barriers to movement away from the farms.

for the four high-wage regions is 71 percent—a difference which is significant at the 5-percent level.

In contrast to the conflicting results obtained with the sample of hired agricultural workers who changed industry or job, the regressions describing the labor market behavior of those employed in the agricultural sector in both 1957 and 1960 are quite consistent with one another. In both (4e) and (5d), the earnings variable is significant, with the expected positive sign, and both show a significant age-group earnings variable with the appropriate sign—negative in (4e) and positive in (5d).²⁷ About the only difference in the two regressions is the weakness of the age variable in (5d) and the previously noted lack of significance of the labor-demand variable in (4d). However, in general, the two regressions suggest that the geographic migration patterns of workers who remained in agriculture over the period 1957-1960 are quite consistent with the hypotheses developed earlier. The one disturbing factor is that, at best, these regressions explain only 30 percent of the variation in movement patterns. By contrast, (a) a similar analysis of geographic movement patterns of all workers in the sample from which these data were taken explains about two-thirds of the variance,²⁸ and (b) Tyrchniewicz and Schuh [15] obtain R^2 which with one exception are in excess of 0.90 in their analysis of the supply of hired agricultural labor by region.

When my results are compared with those obtained in analyzing the nonagricultural portion of the sample used in this article, their low explanatory power probably reflects (a) the fact that the agriculture portion of the sample is relatively small and, consequently, the sampling errors are large relative to the magnitude of the observations and (b) the fact that the hypotheses advanced here explain a smaller portion of geographic mobility patterns among agricultural workers than among all workers.²⁹ When contrasting these results with those of Tyrchniewicz and Schuh, we must remember that those authors use time-series data and include in their regressions a trend term and a distributed lag variable, both of which are absent from my regressions. Generally, these two variables are quite significant in their analysis. The significance of the trend variable suggests that there are factors at work in the agricultural mobility process which are not measured by the variables which I have employed. Further, the adjustment coefficients estimated by Tyrchniewicz and Schuh in connection

²⁷ In regression (5d), earnings and age-group earnings are significant at the 5-percent level; distance, scale, and the demand variable at the 0.05-percent level; and age at the 10-percent level. The elasticities are as follows: earnings +1.48; distance, -1.50; age, -0.70; age-group earnings, +0.96; and demand, +0.55.

²⁸ These results are contained in Chapters 7 and 8 of my "Geographic Labor Mobility in the United States: 1957-1960."

²⁹ In another article [6], aggregate regression results for the ten broad industrial categories enumerated in fn. 1 are presented and these indicate that hypotheses of the type advanced here will explain less of the variance for agriculture than it will for most other industries.

with the distributed lag variable suggest that only a fraction of the adjustment to a disequilibrium situation would be reflected in the three-year time period encompassed in my analysis. Thus, my results are not nearly as poor relative to those of Tyrczniewicz and Schuh as the R^2 would indicate.

Conclusions and Policy Implications

The general pattern suggested by the data presented in this article is one which is quite consistent with the formal economic theory of how labor markets operate. Apparently, hired agricultural labor is responsive to earnings differentials between regions as well as to distance, age, age-group earnings, and, in some cases, the demand for agricultural labor. This seems to be particularly true in the case of movements of hired agricultural labor within the agricultural sector.³⁰ All of this seems to imply some degree of efficiency in the operation of the market for hired agricultural labor. However, before adopting too sanguine a view of how well this market operates, we need to take a closer look at the relative magnitudes of the coefficients of the distance and earnings variables in the gross labor flow regressions. These coefficients provide some insight into the "trade-off" between earnings and distance in geographic movement. Since the distance variable is defined in terms of numbers of regional boundaries that must be crossed in moving from region to region, dividing the distance coefficient by the earnings coefficient provides an estimate of the differential in earnings which is just sufficient to compensate for the presence of an additional regional boundary to cross.³¹ Such a calculation reveals that among agricultural workers who did not change their industry of major job, the impact of an additional regional boundary is just offset by an earnings differential of about \$750. This is quite consistent with an estimate of such a trade-off for all workers in the economy.³²

A trade-off of this magnitude between distance and earnings is difficult to explain as a measure of the costs of movement between regions. If regional earnings differentials are viewed as being relatively permanent in nature, a maximizing worker must be considered to compare movement costs with the discounted value of a future stream of earnings differentials.

³⁰ This is consistent with the findings of Tyrczniewicz and Schuh [15], who argue that hired agricultural workers participate in a national labor market.

³¹ In effect, this procedure amounts to asking the question, "What earnings differential will exactly compensate for the presence of an additional regional boundary to cross?" For example, in regression (5d) an additional regional boundary causes a decline in the gross flow of labor from the i th to the j th region of 0.83 workers. Since each dollar of earnings in the j th region increases the gross flow from i to j by 0.0011 workers, it would require about \$750 of earnings in the j th region to increase the gross flow from i to j by 0.83 workers and cancel out the effect of the additional regional boundary.

³² Calculations contained in Chapter 2 of "Geographic Labor Mobility in the United States: 1957-1960" indicate a trade-off of about \$770 for all workers. Estimates of this trade-off for broad industry groups are presented in Chapter 4 of that work and in my recent study [6].

Clearly, even with a somewhat limited time horizon, the present value of a future stream of earnings differentials that amount to \$750 per year per regional boundary is well in excess of any reasonable estimate of the objective costs of movement. How, then, can these estimates of distance-earnings trade-offs be interpreted? Elsewhere I have argued that they probably represent primarily barriers to the free flow of labor market information.³³ They may also indicate other types of mobility barriers. At any rate, it is difficult to interpret these trade-offs as measuring movement costs per se.

The argument that the size of the earnings-distance trade-off is to some extent an indication of barriers to geographic mobility receives some support when that trade-off is calculated for workers who moved both to a different region and to a different industry. In this case, the trade-off is equal to more than \$1,900 or about two-and-one-half times that for those who did not change their industry of employment. Part of the difference between these two estimates could reasonably be interpreted as reflecting the fact that hired agricultural workers have better information about the market for agricultural labor than they have about the markets for other types of labor. However, the very magnitude of the difference suggests that something other than informational barriers is involved, namely, the presence of substantial barriers to farm-nonfarm geographic mobility. This is quite consistent with certain of our earlier interpretations of the data, particularly those advanced to explain the results of regression (4c).

Overall, the impression generated by the data analyzed to this point is (a) that hired agricultural workers are responsive to economic phenomena when moving between geographic regions and (b) that there are substantial noneconomic barriers to such movement. From the policy standpoint, these findings argue quite strongly that the primary factors holding down income levels among hired agricultural labor are artificial barriers to farm-nonfarm mobility. Clearly, agricultural workers seem to be responsive to differential economic advantages, a fact which would imply that in the absence of artificial mobility barriers some improvement in their relative income position would occur. Yet we know that such improvement has not occurred, primarily, I suspect, because of obstacles to the movement off the farm.³⁴ The simplest policy solution to this difficulty (if we assume an objective of raising the relative income of agricultural workers) would be to eliminate these barriers. However, this is easier said than done. For example, formal seniority systems and restrictive hiring practices of trade unions are well established in our society and the prospects of altering them significantly

³³ This argument is contained in "Geographic Labor Mobility in the United States: 1957-1960," and in a recent study [6].

³⁴ The suspicion that the lack of improvement in the relative income position of farm workers lies in obstacles to mobility is certainly consistent with the argument made in my earlier article [4].

seem dim. It is much easier to "buy off" the agricultural sector through various other types of programs which have minimal effects upon the relative income position of agricultural labor.³⁵ Consequently, a somewhat pessimistic view would regard the findings of this article as confirming the belief which I expressed earlier [4] that the market for hired agricultural labor is in a kind of dynamic equilibrium which generates permanent income differentials reflecting the impact of both movement costs and artificial mobility barriers, the dominant element being the latter. If I am correct in my belief that the breaking down of these barriers will be a slow and painful process, the prospects for improving the relative income position of agricultural labor would seem to be exceedingly dim.

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³⁵ For example, Tyrczniewicz and Schuh [15] note that because the long-run elasticity of supply of hired agricultural labor is greater than one, the ultimate impact of policies such as price-support programs is to increase employment rather than incomes among this group.

Rates of Return for Farm Real Estate and Common Stock*

WILLIAM E. KOST

There has been considerable discussion in recent years concerning the income position of the agricultural sector of the economy. Investment analysts are generally pessimistic about investing in real estate—especially farm real estate. Since farm real estate and common stock are very similar, their rates of return take on added significance when these two assets are considered as investment alternatives. A model is presented by which comparable rates of return may be calculated. Income, price, and total rates of return are calculated for farm real estate and common stock for the 1950–1963 period. Rates of return on common stock are larger and show greater yearly fluctuation for this period.

SINCE particular investments fulfill different investor objectives, they fit into different portions of a total personal investment program. Are farm real estate and common stocks close substitutes in an investment portfolio? If they are highly similar with respect to such characteristics as risk, management, taxation, and marketability, then the rate of return becomes a key variable in selecting the class in which to invest. If, on the other hand, these two investment classes are not similar with respect to the above criteria, then they must meet differing investor objectives and cannot be compared on the basis of their rates of return alone.

Inasmuch as both investments represent equity ownership (the interest of an owner in property or in a business, subject to the prior claim of creditors), farm real estate and common stock have many similar characteristics. Both are earning assets and are subject to the same types of risk.

There are three major differences between these two investments. The first is the relative marketability of the two. Farm real estate is an immobile and unstandardized commodity and is therefore traded in relatively unorganized, low-volume, local markets. On the other hand, common stocks, which are more standardized, are sold on large, well-organized, national, or at least regional, markets in large numbers. This difference in marketability affects relative price fluctuations and collateral values of the two assets.

The two investments are also distinguished by the differing degree of ownership. Farm real estate is generally wholly owned by an investor, whereas the investor in common stock is normally a fractional owner. This difference is due, in large part, to industry's being organized in a corporate

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form. In general, the relatively large amount of capital necessary to organize and operate large businesses in the nonfarm sector of the economy, larger than that needed for many farm businesses, causes the corporate form of organization to be more prevalent in industry. This capital can be raised more easily by allowing multiple ownership, and the most efficient method for achieving this is the corporate form of business. Another consequence of this form of organization is the limited liability of common stock. Theoretically this form of organization can also be utilized for farm real estate investments; however, it is infrequently so utilized. Also, a corporation may be wholly owned by a single investor, and any farm real estate advantages due to full ownership will then accrue to the common stockholder.

Finally, investor's attitudes toward these two types of investment differ. There still exists, in many minds, a value for farm real estate which is not directly connected with its economic productivity. In fact, most individuals have a fairly distinct bias either for or against farm real estate. In general, a comparable attitude toward common stock does not exist.

Thus, we can say that farm real estate and common stock, while not identical, are very similar in their investment attributes. Therefore, although the rate of return is not the only decision-making variable, it will be one of major importance. Because of its prominent place in determining the equity in which to invest, I will devote the rest of this article to calculating and comparing rates of return on farm real estate and common stock.

The Model

The total rate of return on an investment has two components: an income rate of return and a price rate of return. The income rate of return is defined as

$$(1) \quad r_{vt} = \frac{Y_t}{V_t}$$

where

r_{vt} is the income rate of return in period t ,

Y_t is the income received in period t , and

V_t is the value of the investment at the beginning of period t .

Both Y_t and V_t are in current dollars. In the case of farm real estate, Y_t equals the net rent to landlords in period t and V_t equals the value of farm real estate owned by landlords at the beginning of period t . For common stock, Y_t equals net profits in period t and V_t equals the market value of the common stock at the beginning of period t . Retained earnings must be included to make the common stockholder's income comparable to net rent to landlords. Net rent to landlords includes two components: the portion of income that may be reinvested in the business and the

portion of income that can be withdrawn from the business by the owner. Thus, net profit from common stock is comparable to net rent received by landlords. Net profit has the same two components: that portion of income which is reinvested (retained earnings) and that portion of income which is withdrawn from the business by the owners (dividends).

The price rate of return represents that portion of the change in value of an investment which changes the investor's real wealth. It reflects changes in the purchasing power of price-sensitive assets. This price rate of return is included in the total rate of return because, as one writer puts it, "this interpretation accords well with common sense: for the gain or loss results from *holding* money claims during a period of changing prices, not from *disposing* of the money claims at some particular level of prices" [2, p. 113].

In determining the price rate of return, the total change in the value of the investment between two periods must be separated into price and quantity components.¹ The separating procedure is as follows:

$$\begin{aligned} (2) \quad V_{t+1} - V_t &= P_{t+1}Q_{t+1} - P_tQ_t \\ &= P_t(Q_{t+1} - Q_t) + Q_t(P_{t+1} - P_t) \\ &\quad + (P_{t+1} - P_t)(Q_{t+1} - Q_t), \end{aligned}$$

where

P_t is the price per unit at the beginning of period t and

Q_t is the physical quantity of the asset at the beginning of period t .

The price component of a change in value is that portion of the change which is due to a change in price. Similarly, the quantity component of a change in value is that portion of the change which is due to a change in quantity. Since the price component plus the quantity component must equal the total change in value, the term $(P_{t+1} - P_t)(Q_{t+1} - Q_t)$ must be allocated between these two. It is neither wholly a price component nor wholly a quantity component, since it consists of changes in both price and quantity. If the rate of change of both price and quantity is assumed constant, but not necessarily equal, between periods t and $t+1$, the remaining term (the final term in equation 2) can be equally distributed between the price and quantity components [1, pp 70-71]. Thus,

$$(3) \quad (\text{Price component})_t = Q_t(P_{t+1} - P_t) + 1/2(P_{t+1} - P_t)(Q_{t+1} - Q_t)$$

and

$$(4) \quad (\text{Quantity component})_t = P_t(Q_{t+1} - Q_t) + 1/2(P_{t+1} - P_t)(Q_{t+1} - Q_t).$$

Only the price component can be utilized in obtaining the price rate of return. If the quantity component is included, it essentially allows the

¹ The procedure for determining the price rate of return is similar to that developed by Boyne [1, pp. 31-33].

investor to count any increased investment as part of his real wealth gain. Therefore, including the quantity component would cause the price rate of return to be overstated.

The price component defined above cannot be calculated unless certain assumptions can be made about the physical quantities of the two assets. If it is assumed that the number of acres and the number of common shares are good measures of the respective quantities, then equation (3) can be used to compute the price components. Such a calculation, however, would not allow for a change in farm real estate from one land use class to another or for an increase in the real assets of a corporation without a corresponding increase in the number of common shares. Since changes in the quality of an investment are not necessarily reflected as corresponding changes in quantity, as measured by number of acres and number of shares, equation (3) cannot be used to calculate the price component.

However, the price components can be calculated by using two types of data for each investment: a current and a constant dollar value series. Since price is constant in the constant dollar value series, it is in reality a measure of the quantity of the investment in dollar terms. The price component will be calculated as a residual (total change in value less quantity component) so that the problem of defining a base-period quantity can be eliminated.

First, two price components are defined:

$$\begin{aligned}
 (5) \quad (\text{Price component})_t^* &= (V_{t+1} - V_t) - P_t(Q_{t+1} - Q_t) \\
 &= (V_{t+1} - V_t) - V_t \left[\frac{P_b Q_{t+1} - P_b Q_t}{P_b Q_t} \right] \\
 &= (V_{t+1} - V_t) - V_t \left[\frac{\bar{V}_{t+1}}{\bar{V}_t} - 1 \right]
 \end{aligned}$$

and

$$\begin{aligned}
 (6) \quad (\text{Price component})_t^{**} &= (V_{t+1} - V_t) - P_{t+1}(Q_{t+1} - Q_t) \\
 &= (V_{t+1} - V_t) - V_{t+1} \left[\frac{P_b Q_{t+1} - P_b Q_t}{P_b Q_{t+1}} \right] \\
 &= (V_{t+1} - V_t) - V_{t+1} \left[1 - \frac{\bar{V}_t}{\bar{V}_{t+1}} \right],
 \end{aligned}$$

where

P_b equals the base period price and

\bar{V}_t equals the constant dollar value for period t .

The methods for constructing these constant dollar values series are presented in the Appendix. One of the above equations excludes and the other includes the term $(P_{t+1} - P_t)(Q_{t+1} - Q_t)$; therefore equation (3) can be rewritten:

$$(7) \text{ (Price component)}_t = 1/2[(\text{Price component})_t^* + (\text{Price component})_t^{**}].$$

By using equation (7) rather than equation (3) to calculate the price component, we can circumvent the problem of measuring the quantities of assets of varying quality. The quality differences have been incorporated into the model by measuring quantity in terms of a constant dollar value. In the determination of this price rate of return for farm real estate, V_t represents the value of all farm real estate. We will assume that the price rate of return for landlords is the same as that for all farm real estate owners.

We then adjust the price component for changes in the purchasing power of money. To make this adjustment, we multiply the percentage change in the Consumer Price Index by the value of the asset at the beginning of each period. The product is the amount by which the current dollar value of the investment must change to maintain its original purchasing power.

Thus, the real wealth change in the value of an investment is defined as

$$(8) \text{ (Real wealth change)}_t = (\text{Price component})_t - V_t \left[\frac{\text{CPI}_{t+1}}{\text{CPI}_t} - 1 \right],$$

where CPI_t equals the Consumer Price Index at the beginning of period t . This real wealth change is that portion of the change in value which is attributed to changes in the investor's expectations of future income streams, future discount rates, and future changes in prices. By adjusting the price component for changes in purchasing power, we force the investment to become a 100-percent hedge against inflation, as measured by the Consumer Price Index.

The price rate of return can now be defined as

$$(9) \quad r_{pt} = \frac{(\text{Real wealth change})_t}{V_t}.$$

The investment's total rate of return can now be computed:

$$(10) \quad r_t = r_{yt} + r_{pt}.$$

The total rate of return as defined in equation (10) is based on the assumption that one dollar received in current income is equivalent to a real wealth gain of one dollar. This is not necessarily the case. How an individual ranks current income gains or losses in relation to real wealth gains or losses depends on his investment goals and objectives. A more general formulation for an investment's total rate of return is

$$(11) \quad r_t = r_{yt} + \lambda r_{pt},$$

where λ is the relative importance of income in the form of real wealth gains or losses compared to current income gains or losses. Thus λ will be

a subjectively determined parameter and may be different for every investor. In the section that follows, however, it will be assumed that $\lambda = 1$.

Computation of the rates of return on farm real estate is based on the USDA Census of Agriculture aggregate data. The rates of return for common stock are based on data from Moody's Investors Service, Incorporated. The common stock data are for a random sample of one hundred common stocks listed on the New York Stock Exchange.²

Because aggregate U.S. data are used, just one rate of return for farm real estate for each year will be obtained. For common stock, however, a rate of return will be available for each stock. The aggregate rates of return for common stock will be calculated as a simple average of the one hundred individual rates of return. This is akin to the investor's allocating an equal amount to each common stock in the sample. These aggregate rates of return are those that would be available to an investor who randomly selected stocks from the New York Stock Exchange.

Results

Table 1 presents the income, the price, and the total rates of return for both farm real estate and common stock for 1950-1963. These three rates of return are calculated by using equations (1), (9), and (10), respectively.

Table 1. Rates of return for farm real estate and common stock, 1950-1963

Year <i>t</i>	Income rate of return r_y		Price rate of return r_p		Total rate of return r	
	Farm real estate	Common stock	Farm real estate	Common stock	Farm real estate	Common stock
	<i>percent</i>					
1950	6.44	17.67	13.53	3.19	19.97	20.64
1951	6.23	13.24	9.42	-1.23	15.65	12.01
1952	5.63	12.53	-0.04	-4.14	5.59	8.06
1953	4.87	13.29	-2.55	16.03	2.32	29.32
1954	4.86	8.78	4.33	24.00	9.19	32.79
1955	4.37	8.81	3.98	9.53	8.35	18.34
1956	4.44	8.07	6.92	-7.67	11.36	0.41
1957	3.86	9.63	4.75	10.47	8.61	20.10
1958	4.12	7.44	7.29	34.72	11.41	42.19
1959	3.32	7.09	4.46	2.00	7.78	9.09
1960	3.23	5.56	0.88	35.53	4.11	41.09
1961	3.44	4.90	4.80	-10.61	8.24	-5.76
1962	3.52	6.59	4.20	2.41	7.74	9.09
1963	3.34	6.95	5.93	6.78	9.27	13.74

The mean income rate of return for the 14-year period is 9.31 percent for common stock and 4.41 percent for farm real estate. Not only is this rate

² By Moody's classification, this sample is composed of 76 industrial, 11 public utility, 8 transportation, and 5 bank and finance common stocks. This sample contains 7.9 percent of the common stocks listed on the New York Stock Exchange.

higher for common stock for the whole period; it is also higher in each of the 14 years. A nonparametric U-test was made, and the alternative hypothesis that the income rates of return for common stock were greater than those for farm real estate was accepted at the 5-percent level rather than the null hypothesis that the rates of return were the same for the two investments [4, pp. 290-294]. Both income rates of return are stable when compared to the price and total rates of return; however, the income rate of return for common stock varies more than that for farm real estate. The standard deviation of the income rate of return for common stock is 3.59 but is only 0.95 for farm real estate. This greater stability of farm real estate may be due in part to the success of governmental income stabilization policies for agriculture.

The mean price rate of return for the whole period for common stock is 8.64 percent and for farm real estate is 4.85 percent. Again a U-test was conducted and, at the 5-percent level, the null hypothesis that the rates of return from the two investments were the same was accepted against the alternative hypothesis that they were higher for common stock than for farm real estate. The price rate of return for farm real estate was greater than that for common stock in 7 out of the 14 years studied. The standard deviation of the price rate of return is 14.45 for common stock and 3.96 for farm real estate. Since the hypothesis was accepted that the mean price rates of return for the two investments were equal, another U-test could be made to test the null hypothesis that the two price rates of return have the same, or identical, populations against the alternative hypothesis that the variation for common stock is greater than that for farm real estate. The null hypothesis was accepted at the 5-percent level.

The mean total rate of return for the 1950-1963 period is 17.94 percent on common stock and 9.26 percent on farm real estate. The U-test's null hypothesis that total rates of return on the two investments are the same was rejected at the 5-percent level in favor of the alternative hypothesis that the total rate of return on common stock was greater than that for farm real estate. The total rate of return on farm real estate was greater than the total rate of return on common stock in 3 years out of 14. The standard deviation of the total rate of return was 14.31 for common stock and 4.47 for farm real estate. The variations in the total rate of return are almost completely dominated by variations in the price rate of return.

A summary of the data is presented in Table 2.³

³ Since rates of return were available for each of the 100 stocks, it was possible to subdivide the sample into four subsamples (the Moody classifications). U-tests were made to find out whether there were any significant differences among the four subclasses. The results can be summarized as follows: income rates of return—Bank & Finance < Public Utility = Industrial < Transportation; price rates of return—Bank & Finance = Public Utility = Industrial = Transportation; total rates of return—Bank & Finance = Public Utility = Industrial = Transportation.

Table 2. A summary of the rates of return for farm real estate and common stock, 1950-1963

	Income rate of return r_i		Price rate of return r_p		Total rate of return r	
	Farm real estate	Common stock	Farm real estate	Common stock	Farm real estate	Common stock
Mean	4.41	9.31	4.85	8.64	9.26	17.94
Standard deviation	0.95	3.59	3.96	14.45	4.47	14.31
$\hat{\alpha}$	6.21	15.01	6.20	6.17	12.41	21.09
$\hat{\beta}$	-0.24	-0.76	-0.18	0.33	-0.42	-0.42

$\hat{\alpha}$ and $\hat{\beta}$ are estimates of the parameters for a trend equation, $r = \alpha + \beta t$, where r equals the rate of return and t equals the year (1950 = 1, 1951 = 2, . . .).

Biases in the Calculated Rates of Return

Certain biases may be present in all the rates of return calculated in this study. These are not net rates of return. They do not reflect any commission or tax charges on the investment income. The only way in which those factors could have been considered would have been to use a cash-flow analysis for differing income classes.⁴

The rates of return on common stock may also show an upward bias that is not present in those on farm real estate. The latter are based on aggregate U.S. data, whereas the former are based, not on data from the whole population of common stocks, but on a random sample taken from a larger, nonrandom sample consisting of the common stocks listed on the New York Stock Exchange, which tends to list the common stocks of the larger, older, and stronger corporations. Because the stocks in this study are listed on a stock exchange they must also meet the requirements of the Securities Exchange Commission. To the extent that these corporations have higher rates of return than unlisted corporations, the computed rates of return are biased upward. This is not a serious bias, however, as the average common stock investor will seldom consider unlisted common stocks. Therefore, although the rates of return on common stock as calculated in this study may not reflect the average for the whole population, they probably reflect the most relevant portion of the population for the average investor.

For the same reason there will be a downward bias in the rates of return on farm real estate. These rates are based on data from *all* farm real estate, from the best to the most marginal land. To the extent that the inclusion of the marginal, low-return farms lowers the increases in value of farms

⁴ Fisher and Lorie made such an analysis [3, pp. 1-21]. But I conducted a U-test and rejected at the 5-percent level the null hypothesis that this study's total rate of return was equal to the Fisher-Lorie rate in favor of the alternative hypothesis that it was higher than Fisher and Lorie's.

and the net rents, the returns on farm real estate are underestimated. We have said that the "listed bias" for stocks is not a serious bias because the listed common stocks reflect the most relevant portion of the population. Similarly, in the case of farm real estate, the relevant portion for the investor should be, not the whole population, but that portion of farm real estate equivalent to the listed common stocks—the "better" farms.

A fourth possible bias may exist in the rates of return on common stock—a "success" bias. The random sample of common stocks was chosen from those listed on the New York Stock Exchange in 1964. Therefore, no corporation that went bankrupt between 1950 and 1964 was included in this sample. New corporations were not excluded, however. In fact, several new or newly listed corporations were included in the sample. Since the number of corporations which went bankrupt during this period was negligible, the "success" bias should not alter the results.

I should mention that the common stock data were not adjusted for different accounting practices used by different corporations but were taken from the corporate statements without alteration. Any attempt to render these data more nearly comparable would have involved many subjective decisions and was beyond the scope of this study.

Conclusions

We have seen that the rates of return on common stock were larger than comparable rates of return on farm real estate between 1950 and 1963. Adjusting for biases tends to lower the rates of return on common stock and raise the rates on farm real estate. Returns on common stock have larger fluctuations or greater risk than returns on farm real estate. These observations, however, apply to the years from 1950 to 1963 and are not meant to be predictions for the future. Future returns will depend on future economic conditions.

Will the rational investor then consider farm real estate investments when they yield a lower rate of return? That depends. There are two situations in which the investor may be willing to accept a lower net return on his investment. The first concerns the degree of leverage one can achieve with the two classes of equities. Leverage is indicated by the total investment relative to the amount invested by the entrepreneur. If the entrepreneur were not allowed to use borrowed money, he would not invest in farm real estate, given this study's results. However, since an entrepreneur's leverage factor may be greater for farm real estate, he may be willing to accept a lower rate of return on the value of the total investment in order to obtain a higher rate of return on *his* invested capital. In the second situation, the entrepreneur may invest in farm real estate despite its lower return if there are nonmonetary considerations. Noneconomic factors may influence an individual's investment decision.

Appendix

Construction of Constant Dollar Value Series
for Farm Real Estate and Common Stock

The constant dollar value series for farm real estate is composed of two parts: a series for farm land and one for farm buildings.

The constant dollar value series for farm land was computed for each census year for each state. The values for intercensus years were estimated on the basis of a linear interpolation between the census years.

Farm land was separated into five groups: (1) unirrigated cropland (2) irrigated cropland, (3) irrigated pasture, (4) unirrigated pasture, and (5) other land. Relative price weights for the base period were computed in terms of the price of unirrigated pasture. The sum of these relative prices multiplied by the number of acres in each land group will thus give the number of pasture acre equivalents. These pasture acre equivalents represent the number of acres of farm land in a state in terms of the number of acres of unirrigated pasture land which they represent. By converting to a common denominator—that is, to unirrigated pasture acres—we can circumvent the problem of quality differences. The pasture acre equivalents are computed as follows:

$$(12) \quad N_{jt} = \sum_{i=1}^5 \frac{P_{ijb}}{P_{4jb}} Q_{ijt},$$

where

i is the farm land group defined above,

j is the state,

t is the census year, and

b is the base year.

Thus,

N_{jt} is the number of pasture acre equivalents for state j at the beginning of census year t ,

P_{ijb} is the average price per acre for the farm land group i in state j at the beginning of the base year b , and

Q_{ijt} is the number of acres in farm land group i in state j at the beginning of the census year t .

The price per pasture acre equivalent at the beginning of the base period for each state can be defined as

$$(13) \quad P_{jb} = \frac{L_{jb}}{N_{jb}},$$

where L_{jb} is the current dollar value of farm land in state j at the beginning

of the base year. By utilizing this base period price and the pasture acre equivalents, we can determine the constant dollar value of farm land for each state for each census year:

$$(14) \quad \bar{L}_{jt} = P_{jb} N_{jt}.$$

The constant dollar value series for farm land for the United States is then

$$(15) \quad \bar{L}_t = \sum_{j=1}^{48} \bar{L}_{jt}.$$

The constant dollar value series for farm buildings is built on a perpetual inventory construction. To the value of the farm buildings in the base year is added the sum of the deflated net investment in farm buildings for the intervening years:

$$(16) \quad \bar{B}_t = B_b + \sum_{k=1}^t \frac{I_k}{BMPI_k},$$

where

B_b is the value of farm buildings in the base period,

I_k is the annual net investment in farm buildings in current dollars at the beginning of period k ($k=1, \dots, t$), and

$BMPI_k$ is the Building Materials Price Index for period k ($k=1, \dots, t$).⁵

The constant dollar value series for period t for farm real estate can now be defined as

$$(17) \quad \bar{V}_t = \bar{L}_t + \bar{B}_t.$$

The constant dollar value series for common stock is a perpetual inventory series. We assume that the value of the outstanding common stock in the first year of this study is a good estimate of the "real" value of the investment in the corporation in that year. To convert this value to constant dollar terms, we deflated it by the Wholesale Price Index for that year. The constant dollar value of the common stock investment in any succeeding year will be this deflated value of the outstanding common stock in this first year plus the sum of the deflated changes in retained earnings for the corporation for the intervening years:

$$(18) \quad \bar{V}_t = \frac{V_1}{WPI_1} + \sum_{k=1}^{t-1} \frac{R_k}{WPI_k},$$

⁵ Net investment in farm buildings is defined as the gross capital expenditures on farm operators' dwellings, service buildings, and other structures, less depreciation of these structures and an allowance for accidental damage; and the Building Materials Price Index is the mean of the House Building Materials Price Index and the Service Buildings and Other Structures Materials Price Index.

where

\bar{V}_t is the constant dollar value of common stock at the beginning of period t ,

V_1 is the current dollar value of the outstanding common stock in period one,

WPI_k is the Wholesale Price Index for period k ($k=1, \dots, t-1$), and

R_k is the retained earnings of the corporation for period k ($k=1, \dots, t-1$).

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Price Signal Refraction in Pork Processing*

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A method of measuring pricing efficiency in objective, quantitative terms is presented. "Evaluation of pricing efficiency" has long been the terminology used in studies of pricing accuracy. The term "price signal refraction" as used here refers to the more specific, quantifiable, and testable concept dealt with in this article. The distortion of price signals passing through one or more levels of the market is analogous to the refraction of light rays. This study evaluated price refraction at one level of the pork market. Regression models were fitted to the individual carcass data from a sample of 300 carcasses. The data were subjected to objective statistical test. The findings indicated that price refraction attributable to weight was small and insignificant but refraction attributable to backfat was large and significant.

THIS article presents a method of objectively evaluating the accuracy of pricing at one level of the pork market. Inaccuracy in pricing is caused by the failure of the pricing system to transmit price signals accurately through one or more levels of the market. Pricing inaccuracy is thus associated with the distortion of price signals. The signal distortion that results is compared to the refraction of light rays. The concept of "price signal refraction" is used in this article to describe the distortion of price signals in their vertical movement through the market system.

Hog pricing methods have been of interest to agricultural economists for some time [4, pp. 462-471]. Much of the previous work has been oriented to measuring the extent to which hog prices paid to farmers reflected wholesale carcass values. For an individual slaughterer, the disparity between prices paid for individual animals or lots of animals and actual values were thought likely to disappear with the purchase of large numbers of animals [2, pp. 344-345]. Engelman *et al.* [3, pp. 13-27] compared several methods of pricing hogs and found that a system based on carcass weight and backfat thickness eliminated 82 percent of the pricing errors that occurred under the usual liveweight method of pricing. Wholesale cutout values of hog carcasses and the prices paid for hogs in each grade were analyzed by Clifton *et al.* [1, p. 611]. Their study compared the wholesale value differentials and live hog sales price differentials. The comparison of these differentials by grade was used as a measure of buying efficiency.

Price refraction in the packer segment of the pork pricing system was the object of analysis here and is defined as follows: the failure of differences in prices received at the wholesale level for pork carcasses of var-

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ious weights and backfat thicknesses to be accurately reflected in price differentials paid at the live hog market level.

Net margins to packers are used as the criteria for evaluating the transmission of price signals. The degree of price refraction is evaluated through statistical analysis of empirical data. A measure of price refraction is developed by comparing cost and revenue functions fitted to individual carcass data. The relative contribution of product characteristics to costs as compared to revenue determines the extent of refraction. No refraction would imply identity of packer price differentials with regard to costs incurred and revenue received for all weights and grades of hogs. Price refraction does not involve absolute size of the margins. However, the absence of refraction would be characterized by equal net margins for all weights and grades of hogs.

Assumptions of the Study

Revenue per cwt. carcass is the best indicator of carcass value when carcasses of different weights and qualities are being compared.

Processing costs (that is, killing and cutting cost) are approximately equal on a per-head basis for all weights and grades of hogs. All other costs are approximately equal per cwt. carcass processed, for all weights and grades of hogs.

Wholesale value of processed pork is reflected in prices of fresh pork to be processed.

Procedures

A stratified sample of 300 carcasses was selected from the regular kill line of a cooperating commercial packer during the period January–March 1966. The experimental design placed 20 carcasses in each of 16 carcass cells on the basis of backfat and weight. The weight divisions were at 14-pound intervals from 135 pounds to 191 pounds. Backfat divisions were at 0.3-inch intervals from 1.0 inch to 2.2 inches. The carcass cell for 135–149 pounds and 1.9–2.2 inches backfat was not filled. The actual sample data was from 300 carcasses in the remaining 15 cells. The sample provided a uniform distribution of carcasses within the range of backfat and weight. All carcasses were dressed and cut by the same personnel according to the standard cut-and-trim procedure of the cooperating packer. The cuts and trimmings from each carcass were marked and weighed individually. The cutout data from each carcass was then used in value determination.

Revenue was computed for each carcass by summing the wholesale value of individual cuts and trimmings. The weight of each cut and the composition of the trimmings were considered in value determination. Cuts were placed in weight categories and priced on the basis of *National Provisioner* weight categories and prices.

Cost was computed for each carcass by summing purchase cost and processing cost. Purchase costs were based on USDA weight and grade standards and prices reported by USDA for the Chicago terminal market. Carcass grade standards were used to determine live hog market grades. USDA #1's were priced as 1's and 2's, #2's priced as 1-3's, and #3's priced as 2's and 3's. The interpolation of grades was necessary because prices are not reported on a single grade basis. Processing costs were computed from historical data of the cooperating packer. The resulting model for processing cost was as follows: $P_c = 6.00617 - 1.27 \ln$ (wt.). Alternative processing costs are also considered in the analysis.

All prices and costs were monthly averages for the months of January, April, July, and October from January 1960 through January 1965.

The sample of carcasses provided the physical data on carcass composition. Average prices of live hogs and wholesale pork cuts for the period 1960-1965 provided the data necessary to develop cost and revenue differentials.

Analysis of Data

Regression models were fitted to the individual carcass data. The results were as follows: $R = 36.41990 - 0.04349X_1 - 1.4752X_2$, with the dependent variable R equal to revenue per cwt. carcass and the independent variables X_1 equal to carcass weight and X_2 equal to average backfat thickness.¹ (R^2 for the model was 0.740.) A test for additivity was conducted with the model $R = a + b_1X_1 + b_2X_2 + b_3X_1X_2$. The t value in testing $b_3 = 0$ was -2.90 , indicating the possible need for a more complex model. The general quadratic model resulted in an R^2 of 0.756. The slightly improved fit did not justify the more complex model.

The cost model results were as follows: $C = 34.78305 - 0.0421X_1 - 0.59206X_2$, with the dependent variable C equal to cost per cwt. carcass and the independent variables X_1 equal to carcass weight and X_2 equal to average backfat thickness. (R^2 for the model was 0.900.) A test for additivity was conducted with the model $C = A + B_1X_1 + B_2X_2 + B_3X_1X_2$. The t value for testing $B_3 = 0$ was 1.25. Use of the additive model for cost was justified. The resulting model for Margin ($R - C$) was $M = 1.63685 - 0.00108X_1 - 0.88315X_2$.

Figure 1 shows in graphic form the relationships among revenue, cost, and margin. A given revenue line, for example, $R = \$27.00$, consists of points indicating combinations of average backfat thickness and carcass weight producing revenue of \$27.00 per cwt. carcass. Also, cost (C) and margin (M) lines indicate iso cost per cwt. carcass and iso margin per cwt. carcass.

The iso cost and iso revenue lines have different slopes. This implies

¹ The correlation (r) of backfat with weight is $+0.19$. The t -ratio for this correlation is 3.42.

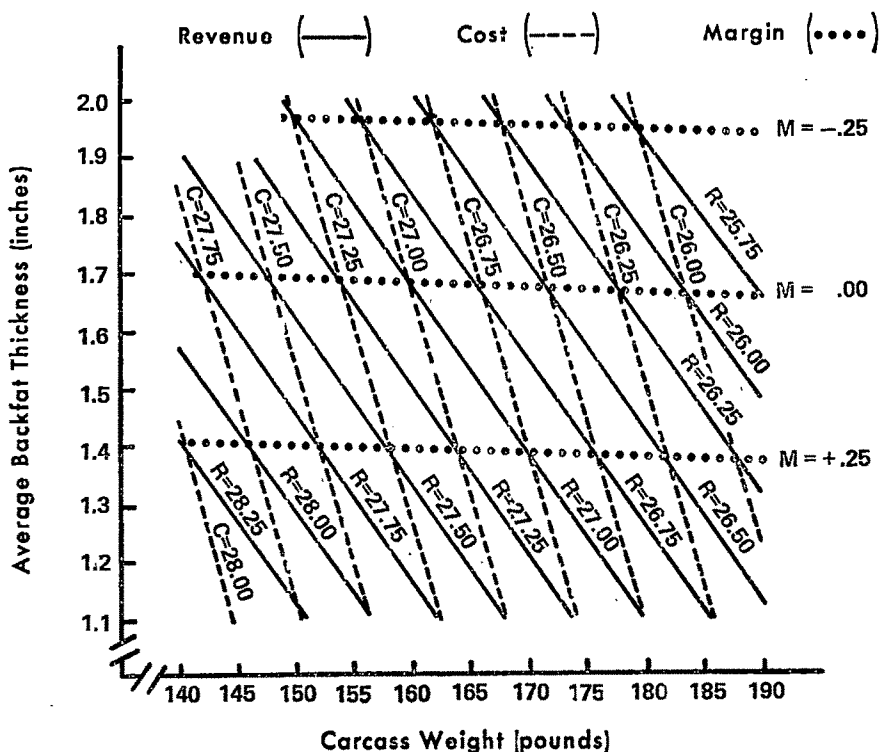


Figure 1. Cost, revenue, and margin as a function of backfat and weight (dollars per cwt. carcass)

that margins are not equal for all weights and backfat thicknesses. Margin differences indicate the presence of price refraction. In the absence of price refraction the relative contribution of backfat and weight to cost and to revenue would be equal. The result would be equal margins for all carcass weights and backfat thicknesses. In graphic terms, the absence of refraction would be characterized by equal slopes of the revenue and cost functions and the absence of intersections of iso revenue and iso cost lines. Consequently, iso margin lines would not exist.

In the diagram, increases in carcass weight and backfat result in decreases in both cost and revenue. However, for a given weight, if backfat is decreased, the increase in revenue is definitely greater than the increase in cost. If backfat is held constant and weight is decreased, the increase in revenue is only slightly greater than the increase in cost. The difference in effect on cost and revenue is greater with regard to backfat than with regard to weight. Consequently, net margins are much more sensitive to changes in backfat than to changes in weight. This fact has im-

portant implications for an individual firm as well as industry implications which will be developed shortly.

Since this study is based on a sample, conclusions concerning the processing industry must rely on statistical inference. The inferences are accurate only to the extent that the sample data and the cost and revenue sources are representative of the industry. However, the underlying principles of the analysis are valid.

If price refraction did not exist, the regression coefficient of cost on weight (B_1) would equal the coefficient of revenue on weight (b_1). Also, the coefficient of cost on backfat (B_2) would equal the coefficient of revenue on backfat (b_2). The resulting margin model would be a constant function equal to the difference between the y intercept terms in the cost and revenue models.

Revenue and costs for the study were derived from independent sources. This fact, with a sample size of 300, allowed the use of the normal curve. The test statistic z for testing $B_1 = b_1$ was 0.49. The size of the statistic indicates that price refraction with regard to carcass weight is relatively small. In fact, a sample test statistic of this size or larger could be expected about 62 percent of the time in the absence of any price refraction. The test statistic for testing $B_2 = b_2$ was 7.72. This indicates a high degree of refraction with regard to backfat. The probability that a test statistic of this size is the result of sampling error is, for all practical purposes, zero.

An alternative approach to price refraction analysis is to regress the margin for each carcass directly on backfat and weight. This procedure, however, is less informative than the cost and revenue approach. The direct margin model for the carcasses in this study was $M = 1.82655 - 0.00270X_1 - 0.84191X_2$. The independent variables again were X_1 , which is carcass weight, and X_2 , which is backfat thickness. The t values for testing $b = 0$ were -1.19 for b_1 and -7.66 for b_2 . The results were consistent with the cost and revenue approach. The weight coefficient was not significant, whereas the backfat coefficient was highly significant. R^2 for the model was 0.182. The partial r^2_{M2-1} was 0.165. This implies that 16.5 percent of the variation in margin not associated with weight is associated with backfat. The partial r^2_{M1-2} was 0.005. In the absence of price refraction, all variation in margin would be expected to be random. This is a shortcoming of the direct margin approach, since variables highly significant in cost and revenue determination would be nonsignificant in the direct margin model. The direct margin approach, however, provides an excellent check of the cost and revenue analysis. Use of the direct margin model alone would require a much higher degree of sophistication in analysis of the margin function than is presented here.

The effects of alternative processing costs were studied in order to fa-

cilitate more general conclusions. Alternative costs were assumed to be a constant charge per carcass. The direct margin model assuming no processing charge produced highly significant t values for testing $b = 0$ for both weight and backfat coefficients. As successively higher processing charges were added, the t value for the weight coefficient decreased and the t value for backfat remained stable. At a processing charge of \$3.50 per head, the t value for the weight coefficient was 1.41. In general, any relevant processing charge above \$3.50 per head would have led to an outcome consistent with conclusions reached by use of the processing cost of the cooperating packer.

The conclusions were that price refraction attributable to weight was small and insignificant. However, price refraction attributable to backfat was found to be large and highly significant.

Implications

Price refraction within the industry

The analysis indicated refraction of price signals in the packer segments of the pork marketing system. Specifically, the refraction was of price signals associated with backfat thickness. This implies that price signals are not being accurately conducted through the packer segment. The refraction could be the result of several factors. Lack of knowledge of carcass revenue in relation to backfat would cause a distorted or vague image of the revenue function. Inability of buyers to discern backfat differences in live hogs could cause distortion of the price signals. Inability of the present buying system to discriminate on the basis of backfat may have caused packers to ignore this factor and fail to conduct these pricing signals. Another possibility is that price-quantity relationships make it more profitable for the packing segment to maintain margin differences. This latter possibility would cause intentional refraction of the price signals.

Price refraction within the firm

Price refraction within a firm means that margins are greater for some products being processed than for others. This again could be either intentional or unintentional. Intentional refraction would imply that greater profits could be attained by maintaining unequal margins. Unintentional refraction would imply inefficiency of the packing firm in receiving or transmitting the pricing signals. This could be the result of lack of knowledge of the firm's revenue function or inability of the firm to conduct price signals accurately. Inability of a packer to price hogs accurately with regard to backfat could well be the result of present hog buying practices. Regardless of the cause, profit maximization for the individual

firm in the presence of unintentional price refraction would be purely guesswork.

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U.S. Import Demand for Green Coffee by Variety*

JOHN NDUKA ABAELU AND LESTER V. MANDERSCHIED

Total United States imports of green coffees were divided into three principal components: milds, brazils, and robustas. The aim was to clarify the demand relationships among the major coffee varieties traded internationally and the factors influencing coffee prices by variety. A nine-equation model of the U. S. coffee market was constructed, consisting of import-demand, export-supply, and stock-demand functions describing the structural mechanisms underlying the market for each of the three coffee varieties. Estimates of structural parameters were obtained by different estimation methods, but only three-stage least-squares results are reported in this article. Parameter estimates suggest that milds (the premium coffee variety) are normal economic goods, whereas brazils and robustas are inferior goods with respect to the U. S. economy. Income flexibility estimates at the mean were 0.39, -0.89, and -1.82, respectively, for milds, brazils, and robustas. Estimated price flexibilities at the mean were, for the three coffee varieties in the same order, -0.18, -0.21, and -0.36. These figures suggest that demand for individual coffee varieties is reasonably price-elastic.

PUBLIC and private decision makers frequently require knowledge about economic parameters of particular varieties of a commodity rather than the total commodity. This is true, for example, of government policy makers in the countries exporting green coffee, since these countries generally produce no more than one coffee variety. Where more than one variety is produced, differences in structural parameters may call for different policy actions.

This article describes the estimation of price and income flexibility coefficients with respect to the U.S. coffee market. These estimates are applied later in a limited evaluation of the international coffee agreement.

General Background

Two of the three coffee varieties in this study, namely milds and brazils, are produced mostly in North and South America. While Colombia supplies the bulk of world requirement for milds, other important sources of this coffee variety in the western hemisphere include El Salvador, Guatemala, Costa Rica, and Mexico. Substantial quantities of mild coffees also come from African sources, such as Ethiopia, Kenya, and the Congo. Milds are generally considered the premium coffee; they are responsible for much of the aroma and preferred flavor of coffee blends. As the name im-

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plies, brazils are supplied exclusively by Brazil, which also is the world's foremost producer of coffee. Brazils are generally believed to provide a less desirable flavor and are therefore used primarily in blends with the milds. The robusta variety comes mostly from African sources, notably the Ivory Coast, Angola, and Uganda. Robustas are nearer the brazils than the milds in flavor and aroma; they are generally considered substitutes for brazils even though rated inferior to them by some in the trade [12, p. 3].

These varieties of coffee are sometimes differentiated on the basis of use. For instance, robusta coffee has generally been the most important ingredient in the manufacture of instant coffee because of both a lower price structure and technical properties.

With the increasing consumption of instant coffee, particularly in the period since 1950, robusta coffees have captured a substantial share of the U.S. coffee market. In 1951, for instance, coffee imports into the United States from African sources amounted to about 4.8 percent of the total import of the commodity, but in 1963 the figure was 21.4 percent—a growth indicative of the strong inroad robustas had made into blend formulations [6, p. 31].

In the past, coffee analysts have been concerned with estimating coefficients from demand functions for total green coffee, thus implying a high degree of structural homogeneity within the commodity group. Hopp and Foote utilized a single demand equation for total green coffee connecting import value per pound to three independent variables. No estimates of price and income elasticities were made [3, p. 429]. A later study by Daly also utilized a single-equation model relating the New York price of Santos 4 (a commonly quoted grade of brazils) to three independent variables. Estimated income flexibility of demand for the prewar and postwar periods, respectively, were 0.71 and 1.51, and the associated price flexibilities were -2.07 and -2.26 [1, p. 61].

The aggregation in these studies on green coffee leaves an impression that there are no significant economic differences among varieties of coffee. In this study we attempt, using more recent and complete data, to separate the three principal coffee varieties and thus check the assumption of homogeneity.

Rationalization of the Economic Model

Prime concern is with the explanation of the prices of milds, brazils, and robustas. In consequence, the price variable was chosen as the normalizing variable in the structural demand relations.

Three equations were constructed for each variety of coffee, namely import demand, export supply, and stock demand equations. In the import demand function, price of each variety was hypothesized as a func-

tion of quantity of imports in the current period, price of the closest rival coffee variety, end-of-quarter inventory, production of processed coffee, and disposable personal income. Export supply was assumed to be functionally related to two factors—expected wholesale spot price and the quantity available for export at the source of supply. Finally, the stock demand equation assumed that end-of-quarter inventory could be explained by an expected wholesale spot price, production of processed coffee, and stocks in the same quarter of the previous year. The economic rationale of the structural equations constructed is given with respect to mild coffees. Similar economic reasoning applies to other varieties.

In the demand function for milds (equation 1, p. 237), an inverse relation was hypothesized between price and quantity in conformity with economic theory, but price was assumed to be positively related to the price of brazils,¹ the end-of-quarter inventory of milds, production of regular coffee, and disposable personal income. With the exception of price, other variables were defined on a per capital basis, using U.S. population, fifteen years old and above, for conversion. A trend variable, initially specified, was later dropped because of high intercorrelation with the income variable. Exclusion of the trend variable raised problems. Conceptually, the model does not separate the effects due to technological progress or changes in consumer tastes, effects measured by the trend variable, from changes due to the income factor. To the extent that technological and taste effects were captured, the interpretation of the income coefficient is no longer clear-cut. It reflects changes in income, technology, and tastes.

We assumed that brazils, more than robustas, are close rivals to mild coffees: hence, the positive relation between the prices of brazils and the prices of milds. This assumption is realistic, since Brazil has been exporting an increasing proportion of high-quality grades. The New York spot price of Santos 4, deflated by the BLS index of spot market prices (1957–1959 = 100), was selected as a representative price for brazils. Current inventory activity influences coffee prices, causing an upward pressure on price during periods of stock accumulation, and vice versa. This is, however, a two-way process in the sense that low prices can also induce stock buildup by dealers and processors whereas high prices can have the opposite effect. Because of this, a mutual dependency was assumed between inventory and price; hence, both were defined as endogenous variables. Production of regular coffee was treated as an exogenous variable, with the reasoning that coffee consumption is a function of the overall state of the economy, of which the coffee sector is but a small part. Similar thinking led to the view that personal disposable income was

¹ Only the price of the coffee variety considered the closest rival to the variety of concern is included among explanatory variables.

exogenously determined. Some doubt was felt about whether or not any appreciable connection existed between income changes and the consumption of coffee. It was considered, however, that although the total consumption of coffee might not be appreciably responsive to income changes, the situation could be different with respect to individual coffee varieties. For instance, an increase in income and personal level of living could result in greater consumer demand for high-quality retail coffee brands and thus in increased use of mild coffees.² Income data were deflated by the BLS index of consumer prices (1957-1959 = 100).

The export supply function (equation 2) expresses the quantity of milds imported by the United States as a positive function of expected New York spot price and the quantity of coffee available for export at the source of supply, specifically Colombia, which is the biggest producer of milds. The naïve measure of expected spot price used was the arithmetic average of spot prices in the two preceding quarters. Coffee shipments to the U.S. market necessarily respond to favorable price prospects, and, within limits, such shipments are also influenced by the amount of coffee available in the producing countries. Ideally, available coffee exports should be measured by production less domestic consumption and retention. Because of data difficulties, an approximation was provided by the total coffee exports in the relevant period. Available coffee exports and the expected spot price are both assumed to be predetermined. Certain factors which probably affected coffee exports were omitted. These factors include official policies with regard to export price minima, coffee taxes, and special coffee exchange rates. Use of these policy instruments undoubtedly interfered with exports of the commodity and heightened speculative dealing among traders. But data problems precluded meaningful specification of such factors, thus contributing to less accurate results.

The final structural relation for mild coffee refers to inventory demand. This was assumed to be negatively related to the expected spot price and positively related to current production of regular coffee and lagged stocks. In a period of intensive roasting of coffee, existing inventory might be drawn down considerably and new purchases would have to be made for replenishing stocks. Stocks lagged four quarters is a variable used to reflect the seasonal variability of stocks, which is thus permitted to change over the course of time. Further experimentation with this variable might be desirable, since the present variable treats unusual stocks in one year as indicative of a change in the desired level of stock.

² Vickery uses a similar argument when he suggests that any good that is so closely defined as to cause the next higher grade of the same general class of commodity to be considered a separate good will be an inferior good over the range of incomes above the income level to which the good in question is best suited [11, pp. 58-59].

While this model uses quarterly data, the final model does not incorporate the usual dummy variable seasonal shifters. Inclusion of the shifters did not add significantly to the explained variance.

The remaining structural equations are essentially the same as those just described. The next set of three equations refers to brazils and the final set to robustas, making a total of nine equations in the complete model. One important difference in connection with the robusta demand relation may be noted: many experienced students of coffee marketing have stated that the growth of instant-coffee markets, especially during the 1950's, was a major influence on robusta trading [2, p. 15; 7, p. 7]. Because of this, the production of instants, rather than regular coffee, was specified in the robusta demand relation.

Statistical Procedure

Data used in statistical estimation pertain to coffee marketing by quarters for the years 1953-1961, earlier data being either unavailable or inadequate. The period subsequent to 1961 was excluded because of the International Coffee Agreement, which is believed to have caused extensive changes in the conditions underlying coffee marketing.³ This analysis, we hope, will be helpful in evaluating the effects of the agreement.

U.S. demand for milds is measured by U.S. coffee imports from Colombia, the biggest producer of the variety. Brazils are measured by coffee imports from Brazil and robustas by imports of coffee from Angola and the former French West African territories.⁴ These countries are the major suppliers of the varieties of concern to the U.S. market, and, since coffee imports are not classified by type, this is a way of separating varieties. Inventory data also are not available on a variety basis. To estimate the quantity of each variety in total U.S. coffee stocks, at the end of a quarter, we simply multiplied total stocks by a number representing the proportion of that variety in total coffee import in the current quarter.

For purposes of statistical estimation, the predetermined variables, X_t , are assumed to be uncorrelated with the disturbance terms, which, in turn, are assumed normally distributed, with a zero mean and constant variance. Three-stage least-squares procedures were used to estimate the coefficients.⁵ Theoretically, these estimates are asymptotically unbiased,

³ Under the International Coffee Agreement, export quotas are the key instrument for achieving stability of coffee prices. Exporting members account for almost 97 percent of total world coffee exports.

⁴ Major data sources included U.S. foreign trade statistics [8], annual coffee statistics published by the Pan American Coffee Bureau [5, 6], U.S. Department of Commerce publications of coffee inventory and roasting [9], and monthly price data furnished by the Sugar and Tropical Products Division of the USDA.

⁵ The iterative three-stage least-squares procedure resulted in cycling, presumably because of certain very small coefficients which changed continually during the iteration process. Limited-information single-equation procedure gave the least satis-

efficient, and consistent [13, pp. 54-78]. The complete statistical model is now presented:

- (1) $Y_{2t} = \lambda_{1t} + \alpha_1 Y_{1t} + \alpha_2 Y_{3t} + \alpha_3 Y_{4t} + \beta_1 X_{1t} + \beta_2 X_{2t} + U_{1t}$
- (2) $Y_{1t} = \lambda_{2t} + \beta_3 X_{3t} + \beta_4 X_{4t} + U_{2t}$
- (3) $Y_{4t} = \lambda_{3t} + \beta_5 X_{3t} + \beta_6 X_{5t} + \beta_7 X_{6t} + U_{3t}$
- (4) $Y_{3t} = \lambda_{4t} + \alpha_4 Y_{2t} + \alpha_5 Y_{5t} + \alpha_6 Y_{7t} + \beta_8 X_{1t} + \beta_9 X_{2t} + U_{4t}$
- (5) $Y_{7t} = \lambda_{5t} + \beta_{10} X_{7t} + \beta_{11} X_{8t} + U_{5t}$
- (6) $Y_{5t} = \lambda_{6t} + \beta_{12} X_{5t} + \beta_{13} X_{7t} + \beta_{14} X_{9t} + U_{6t}$
- (7) $Y_{6t} = \lambda_{7t} + \alpha_7 Y_{3t} + \alpha_8 Y_{8t} + \alpha_9 Y_{9t} + \beta_{15} X_{2t} + \beta_{16} X_{10t} + U_{7t}$
- (8) $Y_{8t} = \lambda_{8t} + \beta_{17} X_{11t} + \beta_{18} X_{12t} + U_{8t}$
- (9) $Y_{9t} = \lambda_{9t} + \beta_{19} X_{11t} + \beta_{20} X_{13t} + \beta_{21} X_{14t} + U_{9t}$

where

t is the time period (quarter);

Y_1 is the per capita⁶ volume of United States coffee imports from Colombia;

Y_2 is the average wholesale spot price of milds (represented by MAMS, New York) deflated by the BLS index of spot prices of 22 basic commodities (1957-1959=100);

Y_3 is the wholesale spot prices of brazils (represented by Santos 4, New York) deflated by the BLS index of spot prices of 22 basic commodities (1957-1959=100);

Y_4 is the per capita stock of milds in the United States at the end of the current quarter;

Y_5 is the per capita volume of United States coffee imports from Brazil;

Y_6 is the weighted average wholesale spot price of robustas (represented by Ambriz 2AA and Ivory Coast Superior Courant, New York) deflated by the BLS index of spot market prices of 22 basic commodities (1957-1959=100);

Y_7 is the per capita stock of brazils in the United States at the end of the current quarter;

Y_8 is the per capita volume of robusta imports from Angola and the Ivory Coast Republic;

Y_9 is the per capita stock of robustas in the United States at the end of the current quarter;

factory statistical fit of all the estimators employed--in some cases it yielded negative R^2 values, implying that use of the mean alone would have yielded estimates with a smaller variance.

⁶Population used for all per capita calculations is the total U.S. population (excluding armed forces abroad) 15 years old and above.

- X_1 is the per capita production of regular ground coffee in the United States, lagged four quarters;
- X_2 is the per capita disposable personal income in the United States, deflated by the BLS Consumer Price Index (1957–1959 = 100);
- X_3 is the expected wholesale spot price of milds (see Y_2), measured simply by the arithmetic average of the spot price in the two previous quarters;
- X_4 is the available exports from Colombia of milds per capita of United States population;
- X_5 is the per capita production of ground coffee in the United States in the current quarter;
- X_6 is the per capita stock of milds, lagged four quarters;
- X_7 is the expected spot price of brazils (see Y_3), measured simply by the arithmetic average of the spot price in the two previous quarters;
- X_8 is the per capita stock of brazils, lagged four quarters;
- X_9 is the available exports of brazils per capita of United States population;
- X_{11} is the per capita United States production of instant coffee, lagged four quarters;
- X_{12} is the expected spot price of robustas (see Y_6), measured simply by the arithmetic average of the spot prices in the two previous quarters;
- X_{13} is the total available exports of robustas from Angola and the Ivory Coast Republic per capita of United States population;
- X_{14} is the per capita United States production of instant coffee in the current quarter;
- X_{14} is the per capita stock of robusta, lagged four quarters; and
- U_t is the disturbance term.

All the equations except (1), (4), and (7) assume a unidirectional causal mechanism and, consequently, ordinary least-squares estimation was used. Several estimation procedures were employed for equations (1), (4), and (7), but only the three-stage least-squares results are reported below.

Empirical Results

Coefficients of determination were calculated for the equations estimated. The formula used for calculating R^2 was the standard one used in classical linear regression models. Strictly, the formula does not apply in a simultaneous system and was used in the present case only for purposes of comparison among different estimators. Simultaneity of the economic relationships postulated also precluded use of statistical significance tests for serial correlation of disturbances in equations (1), (4), and (7), the equations of primary interest.

Overall, the results of the estimation were considered satisfactory. The structural demand relations (equations 1, 4, and 7) performed very well, with R^2 values higher than 0.90 in every case. Thus, a high proportion of

the variance of prices was explained by the structure formulated. However, the export supply and stock demand functions gave disappointing statistical fits, particularly with respect to milds and brazils, where R^2 values were less than 0.1. Drastic revision of these relationships is clearly needed, but the stock demand function might still prove elusive so long as reliable data on a coffee variety basis are not available. No further discussion of the two structural equations is given in the following sections. The results of the estimation (with standard errors presented in parentheses below the coefficients⁷) were as follows:

- (1) $Y_2 = 21.3515 - 8.6160Y_1 + 1.1612Y_3 - 10.4184Y_4$
 (31.2110) (4.3968) (0.1689) (4.5775)
 $- 0.6757X_1 + 8.9486X_2$ ($R^2 = 0.91$)
 (1.4734) (8.1894)
- (2) $Y_1 = 0.9138 + 0.0027X_3 + 0.0404X_4$ ($R^2 = 0.03$)
 (0.3658) (0.0035) (0.0552)
- (3) $Y_4 = 0.2906 + 0.0002X_3 + 0.0896X_5 + 0.2131X_6$ ($R^2 = 0.06$)
 (0.7977) (0.0047) (0.1421) (0.1744)
- (4) $Y_3 = 56.3122 + 0.6368Y_2 - 2.1095Y_5 - 4.3014Y_7$
 (21.4416) (0.1117) (1.1875) (2.2273)
 $+ 0.2180X_1 - 17.9129X_2$ ($R^2 = 0.93$)
 (1.3465) (5.6516)
- (5) $Y_7 = 0.7814 + 0.0175X_7 + 0.5538X_9$ ($R^2 = 0.07$)
 (1.3422) (0.0125) (0.6657)
- (6) $Y_5 = 2.7320 - 0.1382X_5 + 0.0058X_7 + 0.2492X_8$ ($R^2 = 0.08$)
 (1.2278) (0.2208) (0.0071) (0.1811)
- (7) $Y_6 = 94.2833 + 0.2328Y_3 - 44.0571Y_8 + 0.9372Y_9$
 (29.4304) (0.0964) (18.3448) (0.5288)
 $- 26.4801X_2 + 14.4980X_{10}$ ($R^2 = 0.92$)
 (9.2519) (6.8522)
- (8) $Y_8 = 0.1046 - 0.0023X_8 + 0.3246X_9$ ($R^2 = 0.77$)
 (0.0731) (0.1539) (0.1809)
- (9) $Y_9 = 0.0095 - 0.0011X_8 + 0.2063X_{10} + 0.3716X_{11}$ ($R^2 = 0.45$)
 (0.2357) (0.0023) (0.5130) (0.1673)

⁷ Not all of the digits are significant; four-place results are presented because some coefficients may be utilized in other calculations.

At the point of means, the calculated price flexibility of demand for mild coffee was -0.18 ; a 1-percent rise in the quantity of milds is accompanied by an 0.18-percent fall in its price, the prices of other coffee varieties and income remaining unchanged. For brazils and robustas, the corresponding estimates of flexibility were, respectively, -0.21 and -0.36 .⁸ In an earlier study, Daly [1, p. 61] estimated price flexibility with respect to current U.S. imports plus inventory as -2.07 for the prewar period and -2.26 for the postwar period. Daly's estimates, however, relate to aggregate U.S. demand for all green coffees, not for varieties of coffee, as in this study. Further, our model assumed a mutual dependency among price, quantity, and stocks, whereas Daly combined the last two items into one predetermined variable.

The coefficient of the price variable for brazils included in the demand equation for milds was positive and significant; similarly, the coefficient of the price of milds in the demand function for brazils and the coefficient of the price of brazils in the robusta demand function were positive and significant. Consequently, it was inferred that milds, brazils, and robustas are, largely, mutual substitutes. A unit increase in the price of brazils is associated with the rise of 1.16 in the price of milds and 0.23 in the price of robustas.

Estimated income flexibility of demand was positive in the case of mild coffees and negative with respect to brazils and robustas. Income flexibilities at the point of means were, respectively, 0.39, -0.89 , and -1.82 for milds, brazils, and robustas. These contrast with 0.71 and 1.51 obtained by Daly for total green coffee for the prewar and postwar periods, respectively. It is of economic interest to explain the signs of the income coefficients which are possibly biased. As stated before, because of high intercorrelation with income, the trend variable was dropped from the structural relations postulated. Thus, the model might attribute the effects of technological progress and changes in consumer taste to the income variable. In spite of this difficulty, our total results lead to the tentative conclusion that premium coffees (milds) are normal goods in the U.S. economy, whereas the nonpremium varieties are inferior goods. Other relevant factors remaining constant, further growth in the U.S. per capita disposable income should boost the demand for milds in the United States. Conversely, probably more of the lower-quality varieties would be consumed if income declined.

In light of evidence obtained, we believe that the growth of instant-coffee manufacture and consumption greatly favored trade in robusta coffees, especially in the 1950's. In the robusta demand function, the esti-

⁸ On the relationship between price flexibilities and price elasticities, see Houthakker [4]. Since the varieties of coffee are mutual substitutes, the inverse of the price-flexibility coefficient may not be a good approximation to the corresponding elasticity.

mated coefficient of the variable representing U.S. production of instant coffee was positive and highly significant. Furthermore, if relative prices of the coffee varieties and income do not change radically in the years ahead, further spread in the consumption of instants may be expected to lead to additional gains for robustas in the world coffee market generally.

Conclusions

Parameter estimates concerning the *total* demand for green coffee are not only unsatisfactory for framing national coffee policy but also largely irrelevant in evaluating a country's participation in the International Coffee Agreement [10]. The proper guidelines for national policy are parameters relating to the demand for the coffee variety produced in that country. Had this been appreciated by policy makers in the past, they might have avoided unilateral efforts at supply restriction in the name of "price defense." Historically, supply restriction by regional groups of producers has been a key mechanism by which it was hoped to shore up prices sagging deeply under the pressure of heavy surpluses. But these actions only caused consumers to turn to cheaper substitutes available in other unregulated coffees. The successful entrance of robustas into the world coffee market of the 1950's can be attributed to this factor, in the same way that milds made a breakthrough in the 1930's when Brazil repeatedly destroyed huge quantities of accumulated stocks. In both cases, prices were high enough to permit the development of a substitute coffee variety.

An organization such as the International Coffee Council is probably in the best position to regulate coffee marketing and achieve a measure of price stability, provided that it can survive pressures within its ranks by rival producer groups. Such an organization needs knowledge of the economic characteristics of different varieties of coffee in order to make sound policies. To illustrate, our results indicate that future U.S. demand for milds is likely to be improved with further increase of U.S. consumers' personal incomes,⁹ a factor which signals the possibility of expanding the production of milds profitably. However, a rigid application of export quotas under the international coffee pact can prevent such expansion. Of course, technical changes in coffee processing must also be considered—our economic analysis is limited in applicability to the technological processes in use when these data were generated. Thus, judicious use of export quotas is crucial. In practical terms, this will mean projecting pro-

⁹ This does not necessarily imply that the consumption of nonpremium coffee varieties by the rest of the world will decline. It is quite possible that income in countries outside the United States will not attain levels leading to a major shift towards the consumption of the premium coffee variety. In fact, income growth may stimulate greater consumption of brazils and robustas and so offset, more or less, the fall in consumption of these varieties in the U.S. economy.

spective demand for coffee on the basis of varieties and then assigning country export quotas according to some economically and politically acceptable criteria. The results presented above should provide a start in establishing the kind of economic analysis needed for meaningful policy.

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Measurement of the Impact of Recreation Investments on a Local Economy*

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A from-to type of interindustry model is formulated and empirically implemented to quantify local economic impacts of a transfer nature arising from outdoor recreation. Direct, indirect, and induced sales, income, and employment impacts are derived and multiplier values are calculated. Relationships among the from-to model, supplemental studies, and the analysis of regional benefits for governmental investment decisions are discussed.

THE measurement of economic impacts, whether net national income benefits or transfer payments, can play an important role in the analysis, by governmental bodies, of alternative courses of action. Such estimates can help to clarify the nature and extent of federal, state, regional, and local interest in potential investments and, for this reason, can help to determine the appropriate level of responsibility and form of cost-sharing. The ambiguous concept of "secondary benefits" [2, pp. 17-28; 3, Chap. 7; 10; 18, pp. 8-10] has traditionally been partially directed to such matters.¹

In a recent article, Stoevener and Castle [20] suggest that interindustry models may prove useful as means of quantifying the size and distribution of secondary benefits. However, they add the proviso that such models would have to be "designed to reflect particular local or regional points of view" and that techniques less restrictive in terms of data requirements than input-output analysis would be needed to make the models operational. In this article, we report the empirical implementation of one such model. Attention is focused on the regional economic effects of recreation and, by implication, on the consequences of any investment which facilitates additional recreational activity. (Of course the attendant increase in recreational spending must be estimated independently.) The techniques used lend themselves readily to analyzing other governmental investment decisions and to quantifying the multiplier effects which result from public or private action.

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¹ The phrase "secondary benefits" is ambiguous conceptually because it has blurred the distinction between efficiency benefits and transfer payments, and it is ambiguous in implementation for lack of adequate techniques for estimating economic impacts.

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From-To Models

The basic objective is to develop a procedure to determine the direct, indirect, and induced economic effects of government investment. By using interindustry analysis, we can determine the interrelations of sectors within a local or regional economy and the spread to other sectors of direct and indirect economic impacts originating in any one sector or final demand category.

Although interindustry models may provide the most comprehensive techniques available to quantify the level and distribution of secondary effects, conceptual and empirical problems have reduced their usefulness for regional analysis. These difficulties revolve around the design and construction of the Leontief type of interindustry transactions matrix [12; 13, Chap. 4]. From the standpoint of design, the input-output accounting system usually focuses attention on the technical rather than the trade relationships for the region [14, pp. 169-171]. In order to quantify the secondary effects that are confined to a region, we need purely regional linkages. Such linkages are usually derived outside of the basic accounting framework through the use of secondary studies, but the results are often less than satisfactory [16, p. 372].

From the standpoint of construction, statistical data requirements are extensive. Theoretically, complete specification of either the input or output transactions flows should account for the other set of flows. Empirically, the absence of complete input or output data, especially for the exogenous sectors, normally requires that data on both distributions be gathered. This procedure permits us to fill in gaps in the data which result from the use of only one set of flows and also to make certain cross checks and statistical adjustments [6, p. 411; 16, pp. 371-372; 7, pp. 361-362; 1, pp. 140-141]. However, these requirements make the development of a regional input-output model time-consuming and costly, especially if local data are to be used.

The from-to model suggested by Leven [14] and used by Hansen and Tiebout [6] retains the characteristics of an interindustry model but reduces data requirements and focuses attention on regional linkages. This result is achieved by following output flows only. Thus, the supply and demand equation can be shown as

$$X_i = X_{i1} + X_{i2} + \cdots + X_{in} + Y_i$$

where sales of one of the endogenous sectors, for some stated time period, are represented by X_i . Some of this production (Y_i) may be required by the autonomous or final demand sector(s); other portions may go to any of the endogenous sectors for use as inputs in the production process.

The formulation differs from input-output analysis in that the transactions matrix will show only the inputs from area industries (firms having their sales outlet physically in the area) to other area industries and final demand sales handled by the firms in the region. This formulation permits us to ignore imported inputs and, correspondingly, reduces data requirements. Thus, the model represents, directly, purely regional flows and thereby focuses attention on local impacts caused by changes in final demand.²

Moreover, the primary input sectors (rows) are excluded from the empirically derived transactions table. This formulation permits the "output only" approach to be empirically feasible, because data problems normally occur with the exogenous rows of an input-output table. The transactions table which results is an interindustry type, however, because the productions of the various sectors (rows) flow as inputs to other sectors (columns) and to final demand categories (columns).

Because of these changes, data requirements are less extensive than those normally required for input-output models. Only control totals for each endogenous sector and the distribution of these control totals across the transactions table are required. No data on inputs or the distribution of inputs down the columns are needed. The principal disadvantage of this formulation is that it eliminates the means of cross-checking row and column totals and the respective distributions. This is not a serious disadvantage, however, because it is possible to complete the transactions table empirically with primary data.³

Once a transactions table for a base year has been formulated, the derivation of the trade-production coefficients matrix and its inverse proceeds in the normal manner. The absence of the primary input rows does not affect these calculations because they are considered, with the final demand columns, exogenous. From the total requirements or inverse matrix, derived from a from-to transactions matrix, the direct-indirect sector and final demand multiplier values can be calculated, and induced final demand multiplier values can be determined.

² When the model is used for projection, the assumption of constant technical coefficients, which is the basis of input-output analysis, is supplemented. Because regional linkages are the focus, the additional assumption of stable trade patterns between regions is implicit in the formulation and will normally take on primary emphasis.

³ Use of primary data removes the need to use national production coefficients and, in so doing, to make the questionable assumption of geographically invariant production processes and to ignore trade patterns. In addition, use of national coefficients [5], although placing less strain on data sources, requires that the classification scheme used to identify sectors on the national level must be used in the regional study in order for coefficients to cover corresponding types of firms.

Implementation

The most serious problem involved in using any form of regional inter-industry analysis is that of obtaining adequate and reliable regional data. One of the subsidiary objectives of this study was to develop new sources of data appropriate for regional interindustry models and to extend and refine methods and sources previously used. The classification scheme used to define industrial and final demand sectors for the model was designed specifically to meet the study objective and to reflect the industry mix of the region.

Region

Walworth County in southeastern Wisconsin was selected as the region to be studied. This area was selected because it possesses a diversified economy sufficient in size to encompass a wide range of economic activities and because recreational services are mostly exported (users of recreational facilities are largely from other regions). The year 1963 was selected as the base year.

Sector classification

The county economy was classified into thirty-four endogenous sectors or industries based upon a multilevel SIC code breakdown. Specifically, the following sectors were delineated: seven service; five finance, insurance, and real estate; ten retail; one wholesale; three transportation and public utility; five manufacturing; one construction; and two agricultural. This form of sectoring provides a detailed breakdown of the economy other than manufacturing.⁴

The *a priori* assumption is that in a small regional economy the trade and service sectors are a major link to export markets—particularly recreation exports—and, consequently, can be important sources of regional economic growth. Small areas rarely manufacture a sizable fraction of the goods sold through their trade outlets. Because direct links between manufacturing industries and final markets would not appear in a regional model if commodities bypassed the trade sectors, the retail trade sectors of the sales transactions matrix were entered in gross sales terms and not in terms of gross margins as is usually done.⁵

The classification system which resulted was based on a number of other factors. Among these, the availability and ease of data collection, the need to avoid disclosure of individual firm data, and the level of eco-

⁴ Several other regional studies have also used disaggregated tertiary sectors [4, 8] and the primary activities were disaggregated in Martin and Carter [15].

⁵ To avoid squeezing commodities through the single wholesale sector, however, we completed the wholesale row of the sales transactions matrix in terms of gross margins.

conomic activity within possible economic sectors were all considered important. However, the major factor considered was the importance of various types of industries in supplying the direct and indirect needs of those involved in outdoor recreational activities.

Final demand categories

Five final demand categories were distinguished in the study:

1. Exports (excluding recreation goods and services).
2. Recreation exports (consumption by nonresidents).
3. Households (consumption by local residents).
4. Local governmental operations.
5. Local investment.

The final demand categories cover those sectors whose requirements and levels of operation cannot be adequately explained by the model. These are the products and services which will not be reused in the production process of the region.

One comment concerning the recreation export sector should be made. This final demand category is similar to exports. It is composed of the value of goods and services purchased by nonresidents of the area at the selling firm's location inside the county. It includes sales to seasonal residents, tourists, and others on vacation and recreation trips from outside the region, as well as those consumers in neighboring regions who buy in the study area because of convenience, price, tax, or quality considerations, and people passing through on business trips. Because of the geographic setting of the study area and the existing road connections between major population centers, however, we believe that the latter two types of nonresident buying are relatively small.

Data Sources and Collection

Completion of a transactions matrix in terms of gross sales would be sufficient to permit the derivation of sales multiplier values to show the secondary impacts of sales on the regional economy. However, income multipliers and effects can be derived only if a from-to transactions table is completed in terms of income, because the primary input portion of the normal input-output model has been eliminated. In essence, the relevant portions of the primary input rows of the input-output approach are distributed, in the proper proportions, among the sectors composing the endogenous matrix.⁶ Similarly, employment impacts can be calculated if the from-to matrix is completed in terms of employment.

⁶ The income figures used include the wages and salaries, profits, rents, interest, and depreciation derived from the endogenous sectors but exclude the imports portion of the primary input rows.

Therefore, three transactions tables were formulated—one for sales, one for income, and one for employment. The general approach for all three tables was to derive sector (row) control totals for each endogenous sector and to distribute these totals across the matrix. The basis for this distribution was the response, by the business establishments comprising the sector, to a questionnaire on the destination of sales. This procedure simplified data requirements because the only information required was the total sales per sector, the total income or value added per sector, the total employment per sector, and the sales distributions.

Control totals

Two principal secondary sources were used in deriving the control totals. Sales and income data for the sales and income transactions tables were gathered directly from Wisconsin state income tax returns of the individual firms in Walworth County. A complete list of firm names and owners was obtained from a number of sources, including the Wisconsin Industrial Commission, the Wisconsin Department of Taxation, the Wisconsin State Board of Health, and trade and professional associations.

Each tax return contained the sales figure for the firm and the information necessary to derive the firm's value added or income generated. If a firm did business in more than one county or in other states, the return provided the information needed to determine the portion of the sales and value added attributable to Walworth County. The sales and income information for the individual firms was aggregated by sector and used for the control totals of the sales and income transactions tables.

For employment control totals, the principal source was the unemployment insurance data gathered by the Industrial Commission of the state of Wisconsin. This source is incomplete because only firms employing four or more workers for a stipulated time period throughout the year are included. Thus, seasonal firms and small firms of under four employees would normally be excluded. Questionnaires and secondary sources were used to fill the resulting gaps in order to obtain a complete coverage of the employees of the various sectors. The individual firm employment figures were aggregated by sector to obtain the employment control totals.

Questionnaires

The questionnaires were mailed to the universe of firms contained on the master list, and telephone follow-ups were instituted after two weeks for larger firms (those with gross receipts greater than \$35,000).⁷ Ques-

⁷ Final tabulations showed an overall usable response rate of 32.1 percent accounting for 49.5 percent of the gross receipts of the businesses covered by the 2,000

tionnaire responses were aggregated to the sector level by grouping all the firms in each endogenous sector into three size-groupings based on sales, income, or employment, whichever was appropriate. Means were derived for each size-grouping of each matrix cell by using the appropriate measure of firm size as a weight. Finally, a single mean percentage value for each cell was derived by using as a weight the aggregate total gross receipts, income, or employment of each size-group. The purpose was to remove any bias caused by the fact that the rate of response to the questionnaire was higher for large firms than for small (large firms could sell their output to the various sectors in different proportions than the smaller firms of the same sector).

In addition, the three different size-values were used as weights because the results of the aggregation procedure were used in conjunction with three different control total values. This procedure eliminated the need for assuming that a linear relationship existed between the percentage of a sector's sales made to another sector, the percentage of value added derived from the same sector, and the percentage of employment accounted for by the sector. However, the individual questionnaires refer to sales only and, thus, the assumption is that for any individual firm this linear relationship exists.

Empirical Results

The transactions tables which resulted from the questionnaire aggregation procedure and the control total distributions are useful in viewing the various structural aspects of the area. Only 8.1 percent of Walworth County's \$236,821,029 output^a went to the endogenous sectors. The remaining 91.9 percent was sold to the final demand categories. The two final demand categories representing exports purchased 53.7 percent of the total output, with 44.0 percent going to general exports and 9.7 percent going directly to recreation exports.

The same general pattern holds for the income and employment figures. However, direct supply to the recreational market seems to require a more labor-intensive enterprise than supply to the general export market, since this final demand category took 9.7 percent of the area output but required 13.4 percent of the labor force.

The economy of Walworth County is highly dependent on final demand, particularly exports, and to a lesser extent on direct spending by the household sector. Because of the weak backward linkages of the local economy, there is a small secondary or turnover effect of money spent on

questionnaires at an average cost of 94 cents per usable reply. Details of the data collected and model used are given in the original study [9].

^a This output figure differs from the total shown in Table 1 because of rounding errors which occurred during subsequent operations.

final demand items. The calculation of multiplier values allows more explicit relative comparisons to be made of the indirect effects on the economy of changes in final demand categories and in individual sector outputs.⁹

Direct-indirect multipliers for income, employment, or sales can be calculated for each endogenous sector of the model by totaling the columns of the respective inverse matrices. No induced income multipliers were calculated for individual sectors because of the absence of the household row from the sales transactions matrix [16, p. 376]. The multipliers derived ranged in size from 1.02 to 1.52 for income and from 1.02 to 2.05 for employment.¹⁰

Rather than focus on the impacts of changes in final demand of individual sectors, we will concentrate on determining the relative importance of changes in the final demand categories taken as a whole. In this approach, we emphasize the linkages between the final demand categories and the amount of each industry's output which goes to the endogenous sectors. The output, income, or employment of each industry which was directly or indirectly attributable to each category of final demand can be determined by collapsing the endogenous matrix into the final demand columns. From these values, final demand multipliers can be calculated.

The flows of the endogenous matrices can be traced to the final demand categories by multiplying the respective final demand column vectors, one at a time, by the inverse matrices. For each final demand vector, this procedure shows the total flows generated by that sector. Subtracting the known direct flows to that sector from the total flows yields the associated indirect flows. If this subtraction is done for all final demand sectors, it will exhaust total flows and assign them directly and indirectly to the various final demand categories. In essence, this procedure allocates the inputs to an industry in the same proportions as that industry's output is distributed among the final demand categories and industry groups.

The aggregated results of the matrix multiplication procedure for the three factors are given in Table 1, which contains the sum of the direct-indirect breakdown derived for the thirty-four endogenous sectors. Table 1 suggests that Walworth County is heavily dependent upon exports and that the endogenous linkages are relatively minor. For example,

⁹ The data used to generate the income and employment matrices may cause a slight overstatement of the respective multiplier values. The employment data used includes some workers who are not residents of the county. Likewise, income figures represent some payments to factors outside the county (for example, wages paid to nonresident workers and profits returned to the headquarters of a foreign firm). There is no precise way of accounting for these leakages, but evidence suggests that they are minor [9, p. 40].

¹⁰ The multipliers referred to here pertain to individual endogenous sectors and are not the same as those discussed in the remainder of the article and listed in Table 2.

Table 1. Distribution of annual total factor flows among final demand sectors, Walworth County, Wisconsin, 1963

	General exports	Recreation exports	Households	Government	Investment	Total
Income						
Direct	\$ 56,331,312	\$11,694,914	\$30,919,032	\$ 6,153,305	\$ 5,641,086	\$110,739,649
Indirect	4,185,627	1,093,740	3,183,020	807,662	928,312	10,198,361
Total	60,516,939	12,788,654	34,102,052	6,960,967	6,569,398	120,938,010
Percentage direct	93.1	91.5	90.7	88.4	85.9	91.6
Employment						
Direct	5,535	1,692	3,272	374	580	11,452
Indirect	645	115	362	36	67	1,225
Total	6,180	1,807	3,634	410	647	12,677
Percentage direct	89.6	93.6	90.0	91.2	89.6	90.3
Sales						
Direct	\$104,404,881	\$22,889,859	\$72,564,705	\$ 8,582,747	\$ 9,189,550	\$217,631,742
Indirect	7,952,579	1,929,253	6,048,081	1,431,795	1,951,004	19,312,712
Total	112,357,460	24,819,112	78,612,786	10,014,542	11,140,554	236,944,454
Percentage direct	92.9	92.2	92.3	85.7	82.5	91.8

51.2 percent or \$9,881,832 of the total indirect output of \$19,312,712 was attributable to the two export categories and 10.0 percent was indirectly attributable to final recreation demand. The fact that the percentages of direct to total output were high for all final demand categories indicates the absence of highly developed local linkages between the final demand categories and the endogenous matrix.

Table 1 puts the basic data into a form which permits us to calculate multiplier values. The three sets of multipliers derived are given in Table 2. In the short run, changes can be expected in four of the five final demand categories. Only the demand of the household sector is assumed constant, since changes here are assumed to depend on variations in income resulting from changes in other final demand sectors—the induced effect. For each of the four other categories, we calculate an impact multiplier which shows the direct and indirect effect in relation to the direct effect alone when the direct impact is assumed to be one unit of final demand change.

Two types of induced impact multipliers can be calculated—short-run and long-run [16, p. 376; 6, pp. 409–410]. In the short run, expenditures by the household sector will rise when income increases as a result of increases in demand by other segments. Thus, by assuming that a linear homogeneous consumption function exists for the household sector, we can calculate a new set of multiplier values which include this short-run induced effect. In the long run, local investment and governmental operations can also be assumed responsive to changes in local economic activity, just as consumption was in the short run. This leaves only the two export final demand columns as sources of long-run demand changes.

We derive the short-run induced multiplier by assuming that the household final demand sector is endogenous. Using employment as an example, we calculate the ratio of total employment in the household final demand sector to total employment outside that sector, showing the units created in the household sector for each unit increase in nonconsumption final demand. Thus, the total induced impact for a one-unit change is one plus the ratio value. Multiplying the result by the respective direct-indirect impact multipliers gives the total factor increase per one-unit increase in each exogenous final demand category. This latter operation is performed because a one-unit increase in final demand will, through the indirect effect, cause more than a one-unit increase before the induced effect occurs. The induced multiplier values which reflect the long-run impacts of changes in the export sectors are calculated similarly to those for the short-run impacts except that local investment and government operations are considered endogenous.

The values of the resulting multipliers vary among final demand categories and also among income, employment, and sales. In general, the im-

pacts which would result from changes in recreation final demand spending compared favorably with the effects of changes in the other final demand categories.

From-To Analysis and Regional Benefits

Estimates of economic impacts have a variety of potential uses, especially when economic objectives other than national efficiency become important components for project analysis and selection. Questions relating to the regional development impacts of public resource investment [17] and the increasing professional interest in pricing publicly supplied goods and services [19, 11] further point out the need to be able to quantify the initial impacts and responding effects of alternative courses of public action. When used in conjunction with other studies, from-to models provide a practical tool which can be used to estimate the magnitude and distribution of such economic effects. Given an independent estimate of the initial (direct) impact of a proposed investment, we can derive estimates of net regional benefits (regional benefits minus regional costs) from the income transactions matrix of the from-to model and the associated inverse matrix and income multiplier values. More specifically, given adequate supporting data, we can estimate the regional benefits accruing during the year of model formulation as well as make projections of future benefits.

The magnitude of regional benefits for the base year is derived in two steps. First, the initial (direct) benefits arising from publicly provided recreational opportunities are quantified in the recreation export final demand vector of the model's income transactions table. Assuming that all income generated in this final demand column is due solely to expenditures by those using public facilities, we can calculate total regional benefits which accrue to the region by multiplying the sum of the initial regional benefits (Table 1) by the appropriate income multiplier values for recreation exports (Table 2). Thus, using the figures for Walworth County, we multiply the initial regional benefits of \$11,394,914 by the short-run induced multiplier of 1.52 to derive the total net regional benefit of \$17,776,269.

Only rarely, however, will it be realistic to assume that all initial regional benefits are generated by those visiting publicly supplied facilities. For example, Walworth County has a number of large privately owned resorts whose net income figures make up part of the final demand vector for recreation exports. In such cases, as well as when the model is used for purposes of projection, the initial regional benefits from publicly supplied facilities must be specified from secondary studies. We can specify such benefits by assigning a dollar expenditure value to the number of tourist "visitor-days" anticipated annually for a project and determining

Table 2. Impact multipliers by final demand sector, estimated for Walworth County, Wisconsin

	General exports	Recrea- tion exports	Govern- ment	Invest- ment
Income				
Direct effect	1.00	1.00	1.00	1.00
Direct-indirect effect	1.07	1.09	1.13	1.16
Direct-indirect-induced (consumption) effect	1.49	1.52	1.57	1.62
Direct-indirect-induced (C+G+I) effect	1.77	1.80	—	—
Employment				
Direct effect	1.00	1.00	1.00	1.00
Direct-indirect effect	1.12	1.07	1.10	1.12
Direct-indirect-induced (consumption) effect	1.57	1.50	1.54	1.57
Direct-indirect-induced (C+G+I) effect	1.78	1.70	—	—
Sales				
Direct effect	1.00	1.00	1.00	1.00
Direct-indirect effect	1.08	1.08	1.17	1.21
Direct-indirect-induced (consumption) effect	1.62	1.62	1.75	1.81
Direct-indirect-induced (C+G+I) effect	1.87	1.87	—	—

the proportion of these expenditures going to value added. Information contained in the sales and income transactions tables can be used to carry out the latter calculations.

If the multiplier values are to be used in conjunction with the specified regional benefits of an investment or with projections of future final demand expenditures, it must be assumed that the distribution of final demand expenditures is the same as in the base year. Alternatively, if this assumption cannot be supported, a new recreation final demand vector can be specified for the income transactions table. This final demand vector can be matrix multiplied by the inverse income matrix to obtain the total regional benefit and the information necessary for deriving a new set of multiplier values.

Likewise, the distribution of total regional benefits can be shown. The distribution of the initial regional benefits is given in the recreation export final demand column. If this vector is multiplied by the inverse matrix, the result is the total income per sector resulting from the direct sales of all the endogenous sectors to the recreation export final demand sector.

Finally, it should be noted that of the three income multipliers derived, the short-run induced value was used in the example above. Measurement difficulty aside, the long-run induced multiplier value would be the proper value to use because of the close relationship, in regional areas, between the level of economic activity and the expenditures of households, local government, and business investment. However, both the short-run and the long-run induced multiplier values are likely to be overstated by the approach used here.¹¹ Therefore, the short-run value may be

¹¹ Both values are calculated under the assumptions of linear homogenous consump-

taken as the more reasonable practical approximation of the theoretically appropriate long-run value.

Concluding Remarks

The multiplier values derived permit comparisons to be made of the impacts of various final demand changes on the regional economy and, through the use of the income multiplier values, provide a means of determining the benefits of certain types of activity to the regional economy. However, caution must be used in interpreting such measures. Implicit in the entire framework are the assumption of linearity and the assumption that measured average propensities are equal to the relevant marginal propensities for a study dealing with a single time period. The latter assumption may be warranted in certain situations [21, p. 78].

The model used in this study provides an operationally feasible method for determining the regional benefits resulting from governmental activities and for analyzing regional economies. Because the data requirements are less rigorous than for input-output models, the from-to model can be empirically implemented at low cost and by the use of primary data. Supplemental studies pointing up initial indirect impacts of resource development projects can then be used in conjunction with the model to estimate total regional impacts.

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Utility Analysis in a Practical Setting*

R. R. OFFICER AND A. N. HALTER

An empirical study involving derivations of farmers' utility functions and the accuracy of these functions in predicting practical decisions is here reported. Three models of utility estimation which were used are compared as to their predictive accuracy and usefulness under field conditions. The study tests the hypothesis that maximizing expected utility, as a criterion of decision, is superior to maximizing expected monetary value. Utility functions are derived for two points in time in order to test the hypothesis that, if utility functions are to serve as a guide to the decision maker, they must be derived at each point in time at which decisions are made. Implications for decision-making research and for practical farm decision making are indicated.

THE potential of utility analysis needs little further emphasis. In contrast, the problems associated with deriving empirical utility functions and the means for incorporating them into practical decision making are in need of attention. A great deal of effort has been expended in developing models and testing specific assumptions of utility theory. In particular, psychologists have been active in this field in recent years [7, 26]. Unfortunately for practical decision making, psychologists have conducted their experiments under laboratory conditions with trivial payoffs. Their work has value in that their models and techniques are suggestive of utility measurement in a practical decision-making context. However, the methods must be altered if they are to be suitable for the derivation of utility functions under field conditions. In particular, the gambling context of the experiments has to be modified to reflect how people view real-world decisions. Also, the range of payoffs has to be greatly increased to be relevant to most business, including farm, decisions.

Agricultural economists have shown a continuing interest in utility analysis since the work of Halter and Beringer [12] and the Interstate Managerial Study [14]. P. Johnson [15] examined six empirical studies concerned with price expectations for their consistency with a hypothesis of risk preference among farmers. He concluded that the consistency which he found with the hypothesis required an assumption that farmers are expected-utility maximizers, or that they behave as if they are.

Davidson and Mighell [3] subsequently pointed out that the results obtained by Johnson may be due to communications problems between the

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researcher and his subjects. They concluded that farmers in general have a real aversion to uncertainty. This aversion may not be detected by the hypothetical questions used in most studies of expectations and utility analysis. Thus, farmers' answers to hypothetical questions may not agree with their actual behavior. That the communications problem in doing utility research is a difficult one to handle has been further emphasized by the work of McCarthy and Anderson [18] in Australia. They attempted to derive and apply utility functions for a sample of 66 beef-cattle farmers. But because of communication problems, they found that they were able to derive utility functions for only 17 of their 66 subjects.

Moreover, developments in Bayesian decision making have recently given new impetus to utility measurement. Hildreth [13] gave one of the first generalized outlines of the decision problem under uncertainty. Dillon and Heady [6] showed how decision making could be conceptualized as games against nature; they empirically tested various algorithms as decision criteria for these games. Halter [11] has presented the basic theoretical framework of Bayesian decision making patterned after Chernoff and Moses [2]. Dean [5] has provided a number of empirical applications of the framework to problems of optimum stocking rates on California range land. He also pointed out some of the problems encountered in applying the theory and offered some tentative suggestions towards their solutions. Not least among these problems is the derivation of utility functions. Because agricultural economists have made few attempts to derive utility functions, further attempts to apply Bayesian decision-making concepts to practical problems have been blocked. Without useful utility functions, the suggestions of Tedford [25] for solving decision problems under risk and uncertainty may go unnoticed by actual decision makers. The import of the Bayesian decision-making framework is that the risk and uncertainty elements of the decisions are made explicit.¹

Solving a decision-under-risk problem by using the criterion of maximizing expected utility has been shown to provide decisions which are consistent with the decision maker's preferences among risky alternative actions. Because of this consistency, utility analysis is the only way of accounting for a risk as a parameter in a decision problem [2, 17, 19, 24]. The utility function reduces the dimensions of preferences for risky situations to a single dimension, thus lessening the ambiguity and simplifying the analysis of the decision problem.² The successful derivation of

¹ Since the Bayesian framework allows for subjective probabilities, the range between risk and uncertainty can be included as the area of application. Situations defined as uncertainty by classical workers like Knight [16] become cases of subjective risk for the Bayesian. Henceforth in this article we will refer to the entire range as being a case of risk.

² The decision framework also includes a probability distribution which may be subjective. Specification of a probability distribution for a particular problem is a

utility functions in a practical setting permits Bayesian decision-making concepts to be applied in their entirety to all decision problems under risk.

The objectives of this article are (a) to report the results of an empirical study involving derivations of farmers' utility functions and the accuracy of these functions in predicting practical decisions, and (b) to point out the implications of this study for decision-making research and for practical farm decision making, that is, the use of utility analysis as a prescriptive aid to decision making.

Models of Utility Estimation

A number of models have been suggested for estimation of utility [8]. Three that will be discussed here and subsequently tested are the von Neumann-Morgenstern (N-M) model, a modified version of the von Neumann-Morgenstern (modified N-M) model, and the Ramsey model.

Von Neumann-Morgenstern model

The N-M model is the method most frequently used by economists for deriving utility functions. It is also the method usually prescribed by texts on decision making. Since the use of this model to derive utilities has been described by von Neumann and Morgenstern [27], and in a field study by Halter and Beringer [12], we do not propose to give details of the model here. Suffice it to say that the model rests upon the continuity assumption (along with others [17]), which states: If outcome x_1 is preferred to x_2 , and x_2 is preferred to x_3 (that is, $x_1 > x_2 > x_3$), then there exists a probability $p > 0$ such that

$$pu(x_1) + (1 - p)u(x_3) = u(x_2),$$

where $u(x_1)$, $u(x_2)$ and $u(x_3)$ stand for the utilities of outcomes x_1 , x_2 , x_3 . The utilities of x_1 and x_3 are arbitrarily set and $u(x_2)$ is determined. As many points as desired can be obtained by use of this basic procedure.

There have been two criticisms specifically directed at this model. First, if the subject has a utility or disutility for gambling, then, because he is asked to indicate his preference between the outcomes of a gamble and the outcomes of a certain event, his choice of outcomes will be biased by the process which determined the outcomes. Second, if the subject does not fully understand the concept of probability or has probability preferences, then the subjective probabilities indicated by him for indifference between the gamble and the certain event may not correspond to objective probabilities of the same numerical magnitude [7, 26].

separate task from deriving a utility function for monetary outcomes. Therefore, it is important that subjective probabilities should not be confounded with utility.

Modified von Neumann-Morgenstern model

The N-M model can be modified by using neutral probabilities—that is, $p = (1 - p) = 0.5$ —to overcome bias due to probability preferences.

The subject is presented with the gamble of equally likely outcomes x_1 and x_3 , for which utilities are arbitrarily set. An amount x_2 is determined so that the subject is indifferent to taking the gamble $[x_1, x_3; p, (1 - p)]$ or obtaining the certain outcome x_2 so that

$$0.5u(x_1) + 0.5u(x_3) = u(x_2),$$

where $x_1 > x_2 > x_3$. Once the utility of x_2 is determined, the utilities of other outcomes are determined in a similar manner.

Although this method overcomes bias due to probability preferences, it is still open to criticism because the subject is asked to choose between a risky and a certain outcome. If the subject has any utility (disutility) for gambling, his decision—and hence the point of indifference—will be biased.

Ramsey model

The Ramsey model overcomes both criticisms of the N-M model. Ethically neutral probabilities are used so that there is no bias due to probability preferences. Also, the subject has to choose between two gambles so that there is no bias if a subject has a utility (disutility) for gambling. Davidson, Suppes, and Siegel adopted the basic form of the model suggested (but never used) by Ramsey [23] to conduct their experiments [4]. The procedure used here is a slight modification of theirs.

Assume that a utility function is to be estimated for money outcomes over the range a to g , where $a > g$. The questions following the model are framed as decision problems against Nature in the form of a single-person game. For example, game 1 is framed as follows:

	A_1	A_2
S_1	a	b
S_2	d	c

Outcomes a , b , and c are set, with $a > b > c$. By direct questioning, outcome d is varied until the subject is indifferent between actions A_1 and A_2 . Since $A_1 = A_2$ in preference, then

$$u(a) + u(d) = u(b) + u(c).$$

Therefore, at indifference the utility interval a to b is equal to the utility

interval c to d :

$$u(b) - u(a) = u(d) - u(c).$$

The utility interval a to b is arbitrarily set. Game 2 is then constructed in a similar fashion for given outcomes b , c , and d , so as to determine the amount e such that

$$u(c) - u(b) = u(e) - u(d).$$

The utility interval b to c is arbitrarily set. The relationship between the utilities determined so far is shown in Figure 1. If the process used in games 1 and 2 were continued, two separate, disjunct utility scales would be constructed, each based on the arbitrarily assigned utility interval in the initial two games. To relate these scales, game 3 is constructed for given outcomes b , d , and e , so as to determine a new value of a , called a' , such that

$$u(b) - u(a') = u(e) - u(d).$$

The utility interval a' to b is equivalent to the utility interval e to d , and therefore b to c . The procedure used in the first two games is recommenced, using the new utility interval a' to b ; that is, a new outcome d' is found by forming game 4 with a' , $d' \approx c$, b . The next game determines a new value, e' , that is, game 5, b , $e' \approx c$, d , followed by game 6, c , $f \approx d$, c , where f is the outcome determined for indifference.³ The process can continue for as many games as are required by the number of points on the utility functions. The relations between the utility intervals for a series of seven games are shown in Figure 2. Since the utility interval

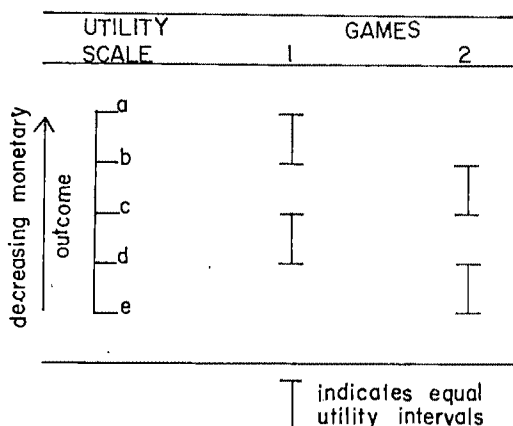


Figure 1. The relationship between utilities of games 1 and 2

³ The symbol \approx indicates $0.5u(a') + 0.5u(d') = 0.5u(c) + 0.5u(b)$ for game 4.

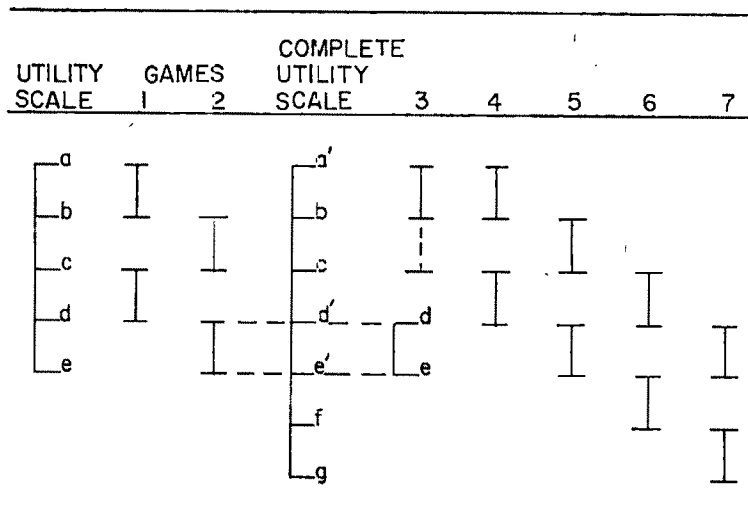


Figure 2. The relation between utility intervals. The broken line between *d* and *e* of game 3 indicates these outcomes are the same as those of *d* and *e* of game 2 and hence have the same utility interval. The utility interval is also the same as *d'* to *e'* but the outcomes may be different.

for *b* to *c* is set arbitrarily and all other utility intervals are equal to this one, the utility value attached to every other outcome can be determined.

Fodder Reserve Problem and the Empirical Study

In May 1965, a questionnaire was mailed to 72 wool producers in northern New South Wales, Australia—a region which at the time was experiencing its worst recorded drought. One question was an open-ended one asking what the farmers thought would be their most difficult problem in coping with the drought. Almost without exception, the answers given by the 45 farmers who completed the questionnaire raised the problem of how to make decisions under the uncertain conditions which prevailed. The 45 farms were stratified into six categories on the basis of property size and stocking rate. One farmer from each of these categories was randomly selected and asked to participate in a more detailed study of "how farmers make decisions."

Utility functions were derived for each of these six farmers and tested against decisions which they made for an operational decision problem. To encourage farmers to take this operational decision problem seriously, the problem was cast in the framework of one of the most pressing problems raised by farmers during the drought, namely the amount of fodder

reserve which should be carried. By keeping the number of participants small and by casting the study in a realistic and important decision context, we found it possible to evaluate the hypotheses of the study in greater depth.

The main hypothesis of the study was that farmers' operational decisions are more consistent with a criterion of minimizing expected disutility (maximizing expected utility) than with the criterion of minimizing expected costs (maximizing expected returns). A subsidiary hypothesis was that useful utility functions could be derived under field conditions. The three alternative models outlined above were used to derive the utility functions and thus permit a comparison of the relative feasibility and suitability of these models under field conditions.

Another hypothesis of the study was that, if utility functions are to serve as a guide to the decision maker, they must be derived at each point in time at which decisions are made. For this reason, the study was conducted in two stages, approximately a year apart, thus providing an opportunity to observe the effect of time on farmers' decisions and their utility functions.

Fodder reserve model

The model used to describe the fodder reserve problem is a simple inventory one developed by Officer and Dillon [21], which generates expected costs and the standard deviations of costs for discrete amounts of reserve. During the first visit to each of the subjects, the fodder reserve model and its advantages were explained. Values for the parameters of the model were collected from each subject and a fodder reserve program was determined for each of the subjects' farms. Together with these farms, fourteen other farm situations were programmed for fodder reserves. An example of these fodder programs is given in Table 1. Each of

Table 1. Sample fodder reserve program as presented to farmers

Months of fodder reserve	Expected cost of this reserve ^a	The actual cost of the reserve will fall in this range 70 percent of the time ^b
0	£899	£372-1,426
1	812	285-1,339
2	859	390-1,328
.	.	.
.	.	.
12	1,631	1,236-2,208

^a The expected cost of the reserve is comprised of the following components: acquisition cost, penalty cost due to a feed shortage, salvage value, opportunity cost of funds, and the probabilities of a feed shortage. £ Australian is approximately \$2.25 U. S.

^b The range represents about one standard deviation about the mean for a normal distribution.

the six farmers was confronted with the programmed situations and asked to make a decision on the level of reserve which he would keep in each case.⁴

Estimation of utility functions

Subsequent to the presentation of the fodder reserve programs, two evenings approximately a week apart were spent with each of the six subjects determining utilities. Utility functions were derived for each subject, using the three models of utility measurement described above. The form of the questions for each model was carefully explained to the subjects, and it took from half an hour to an hour to derive utilities for each model. If a subject's interest in the questions started to wane, then a break was taken and either supper was served or a general discussion, not specifically related to the study, was opened up before returning to the questions. Through this approach, subjects were encouraged to give their full attention to the decisions, both to achieve consistency⁵ and to be sure that their decisions were made with full consideration of the possible outcomes.

All of the questions involved in the models were presented to subjects on cards. The questions were framed in terms of single-person games against Nature.⁶ All probabilities were stated in frequency terms or as equally likely events.⁷

An equation was fitted to each set of utilities derived by each model, with monetary outcomes as the independent variables. The form of function fitted was determined, first, by graphing the utilities for various money outcomes and drawing a freehand curve through the observations

⁴ Each farmer faced between 10 and 19 fodder reserve programs. As the first stage of the study progressed, fodder programs which gave a better test of farmers' decisions were developed, so that not all farmers encountered the same programs. In the second stage, the best 10 programs were selected and all farmers made decisions on the same set of programs.

⁵ Any obviously inconsistent answers were returned to the subject and he was asked whether this was really the decision he intended to make. There were few such inconsistencies, however, and they were usually corrected once the problem was re-presented.

⁶ All questions were explained in such a way as to imply a fodder reserve context because keeping fodder reserves may include other virtues not accounted for in the mean and standard deviation of the different fodder reserve levels. A subject was told that each decision he made related to policy for the next 12 months; thus his customary wealth was taken as the point of origin for his utility function. The stocking rate and the costs of fodder are likely to vary, so the decision problem will change each year. Consequently, the subject was told that he had no opportunity to "average out" over a number of years; that, for example, a particular course of action might result in costs of either £200 or £400, and although this action had an expected cost of, say, £300, he would never realize this amount because he would have no opportunity of taking this particular course of action, with the same consequences, over a number of years to average the actual costs.

⁷ For further details of the methods of presentation and derivation, see Officer [20].

and, second, by using linear, quadratic, and cubic functions fitted to the observations by regression analysis. The form of the function chosen was initially based on the freehand curve and then evaluated further by using F ratios, error sums of squares, and R^2 values. The method used selected that form of function which was most suitable in terms of the subject's choices, rather than that which was desirable on statistical grounds alone, although the two are not incompatible [20].

Predicted versus actual decisions

To obtain predictions of a farmer's fodder reserve decisions from his variously estimated utility functions, it is necessary to show the relationship between the utility function and the mean-variance form of the fodder reserve problems. This relationship is shown for a quadratic utility function by the expected utility equation

$$E(U) = bE(x) + cV + cE(x)^2,$$

where

$b > 0$ and $c > 0$ are constants,

$E(x)$ is the expected outcome, and

V is the variance.

This relationship can be depicted by the three-dimensional diagram shown in Figure 3. This figure describes the utility surface for parameters $E(x)$ and V . The expected utility of any decision with $E(x)$ and V falling within the range specified by the scale must lie on this surface. The criterion of maximization of expected utility selects the act, from a set of possible acts, which falls on the highest feasible point on this sur-

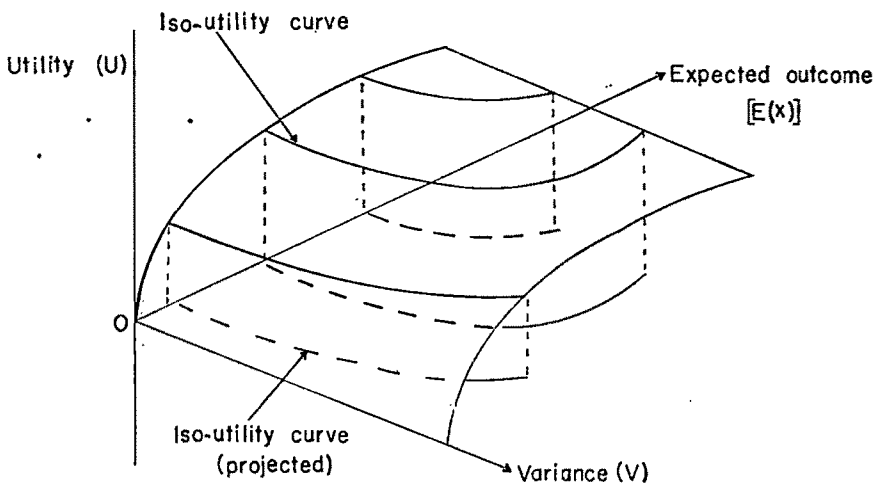


Figure 3. Three-dimensional representation of the relationships among utility, outcome, and variance

face; that is, the expected outcome of this act lies on a higher iso-utility curve than the expected outcomes of alternative acts. The three-dimensional diagram can be projected into the more familiar two-dimensional expected outcome-variance (E - V) indifference system as shown by the projected iso-disutility curves in the E - V plane of Figure 4.

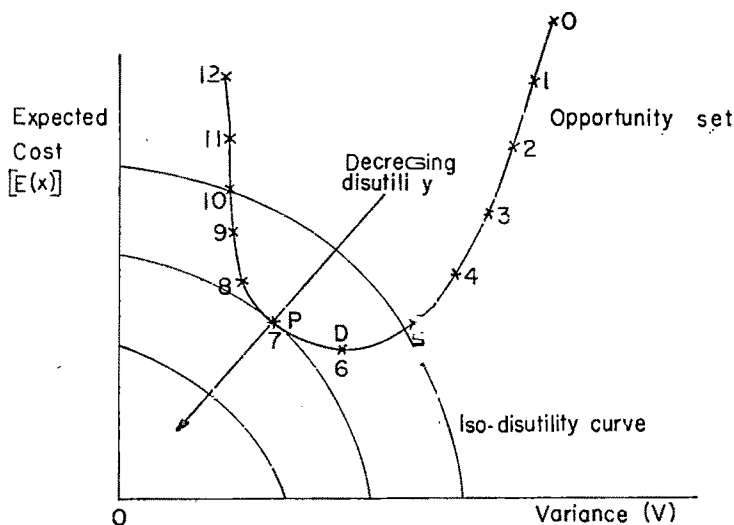


Figure 4. An E - V indifference system for costs and an investment opportunity set for a fodder reserve program

Predictions from utility functions

The expected utility of each possible act (level of fodder reserve) is estimated and the act with the maximum expected utility⁸ is the predicted decision. When the individual's utility function is a quadratic, the expected utility of each act is estimated by use of the equation above.

When the decision maker's utility function is cubic,⁹ the expected utility of an investment which has an expected return $E(x)$ with a variance V is given by the following equation:

$$E(U) = bE(x) + cV + c[E(x)]^2 + d\{3V \cdot E(x) + [E(x)]^3\}.$$

⁸ The fodder reserves were stated in terms of costs; the utilities were estimated for costs: that is, disutility was estimated as a function of costs. Therefore, the actual criterion of decision is minimization of expected disutility. However, for ease of exposition, we will discuss the criterion in terms of expected utility.

⁹ In the derivation of $E(U)$ for a cubic utility function, the third moment about the mean, skewness, enters the expression. However, because the variance of the expected cost of a level of fodder reserve was expressed for a normal distribution, the degree of skewness is zero and hence can be dropped from the $E(U)$ equation.

Specification of accuracy of the predictions

In each of the fodder programs, it was specified that there were 13 permissible levels of reserve (investment), numbered 0 through 12, indicating the number of months of fodder reserve. For each of these levels, the expected cost and standard deviation were specified. These parameters are substituted in the expected utility equations for each type of utility function, and the criterion of maximizing utility chooses that level of reserve which has the minimum expected disutility, since the programs were framed in terms of costs. The relationship between the E-V indifference system for costs and the investment opportunity set for a fodder reserve program is shown in Figure 4.

The decision implied by the decision maker's utility function is at the point of tangency, point *P*, of the investment opportunity set and the minimum iso-utility curve—this is the investment for “minimum expected disutility.” If point *D* is the decision maker's actual choice of investment, then one unit of error for the utility model would be indicated. The numbers of units of error for each fodder reserve program for which the subject gave a decision were averaged for each of the three utility functions. The average number of errors for each utility function served as the basis for judging the accuracy of predictions as well as a basis for comparison between functions.¹⁰

Results

The complete study consisted of two stages separated by a year. Some of the findings of the first stage were used as a basis for the second stage. A time lapse of a year was allowed so that the effect of time on both the farmers' decisions and their utility functions could be studied. Because farmers make their decisions on fodder reserves annually, the two stages of the study were conducted at a time when the farmers would first be considering the next year's fodder requirements.

First stage

Each of the six farmers faced between 10 and 19 fodder reserve programs; each representing a farm situation. Their own farm situation was hidden amongst the programs on which they had to make decisions. We spent from one to two hours with each farmer in explaining both the problems and economics involved in keeping fodder reserves and the meaning of the expected costs and standard deviations of the fodder reserve program. We asked farmers to make their decisions on the programs

¹⁰ This measure of error is in no sense absolute. It is merely a measure of relative accuracy. We could theorize about a more relevant measure, such as consequences to the farmer, but at this stage we are not in a position to estimate such measures.

only after we thought that they had a complete understanding of the problem.

One of the subjects had such strongly held preconceived ideas about fodder reserves that it was impossible to get a sensitive test of utility analysis within the designed framework. We spent three evenings with this farmer in an attempt to modify the format of study so that his decision could be used. Unfortunately, he would not consider holding fodder reserves, even though the opportunity costs for not holding reserves were raised to their feasible limit. Utility functions were obtained from this farmer, but because of his attitude towards fodder reserves, the functions could not be tested alongside the fodder reserve model. Rather than devise another model (other than the fodder reserve decision), we decided to drop him from the study.

Utility functions and predictions

The utility functions derived for each subject, by use of the three models, are shown in Table 2.

Table 2. The subjects' utility functions

Subject and model ^a	Utility functions ^b	R ²
11	$DU = 1.3466118x - 0.0005616x^2 - 0.0000001x^3$	0.997
12	$DU = 0.6780515x + 0.0001214x^2$	0.998
13	$DU = 0.52047663x - 0.00004608x^2$	0.998
21	DU = linear function ^c	0.999
22	DU = linear function	0.971
23	$DU = 0.40865088x - 0.00005451x^2$	0.984
31	$DU = 1.09494028x + 0.00062713x^2$	0.998
32	$DU = 1.3707371x - 0.0000657x^2$	0.998
33	$DU = 0.60085112x - 0.00015136x^2 + 0.00000004x^3$	0.999
41	$DU = 1.9351493x - 0.00003186x^2$	0.996
42	$DU = 0.8179823x + 0.0000604x^2$	0.998
43	$DU = 0.52427426x - 0.00005757x^2$	0.998
51	$DU = 1.12629762x - 0.0005337x^2 + 0.0000001x^3$	0.996
52	$DU = 1.486854x + 0.002904x^2$	0.992
53	$DU = 2.9968986x + 0.0008333x^2$	0.997

^a The first digit indicates the subject; the second indicates the method used to derive utilities, where 1 is the N-M model, 2 is the modified N-M model, and 3 is the Ramsey model. Thus, 12 indicates the utility function derived for the first subject by use of the modified N-M model.

^b The utility functions were derived for a range of costs from approximately £0 to £3,500. DU is the amount of disutility; that is, $DU = -U$; the x 's represent the size of the costs. Approximately 10 observations were taken to derive each function.

^c The disutilities in functions 21 and 22 were linearly related to costs, so that the criterion of minimizing expected costs is equivalent to minimizing expected disutility—risk plays no part in the decisions implied by these functions.

The utility functions obtained from subjects (with the two exceptions of functions 21 and 22) were nonlinear. The high R^2 of all the fitted functions is attributable to the suitability of polynomials for fitting the data and to the relative consistency (relative to the sums of money involved) of all the subjects in indicating choices for the simple games.

The figures in Table 3 give the average units of error between the farmers' decisions on fodder reserves and the results of using the criteria of (a) minimizing expected cost and (b) minimizing expected disutility with three different models.

Table 3. Decision accuracy of the models^a

Subject	Minimizing expected cost	Minimizing expected disutility with three models		
		N-M	Modified N-M	Ramsey
1	0.684	1.211	0.316	1.000
2	0.286	0.286	0.286	0.927
3	0.167	0.167	0.250	0.167
4	0.154	1.231	0.000	0.385
5	1.850	2.300	1.000	1.200
Average error	0.628	1.039	0.390	0.726

^a The figures in the body of the table are average units of error per fodder reserve program, a unit being one month's supply of fodder.

The utility function of each subject, as implied by his decisions on fodder reserves, had increasing marginal disutility. All subjects were therefore to a greater or lesser degree risk averters. The criterion of minimizing expected cost, if not coincident with the farmers' decision on fodder reserves, always selected a plan with a greater variance than that selected by the farmers. Therefore, if the assumption is true that farmers made their best decisions for the fodder reserve programs, then the utility function of money over the range of costs involved in fodder reserves should show increasing marginal disutility throughout.

The criterion of minimizing expected disutility, where the utilities were derived by method 2 (modified N-M model), was superior to the criterion of minimizing expected cost. The utility functions derived by use of the modified N-M model for subjects 1, 4, and 5 were of the type implied by their decisions on fodder reserves. The function for subject 2 was linear. Subject 3's utility function (that is, 32) showed decreasing marginal disutility, which implies a risk preference over the range, although the rate of decreasing marginal disutility was slight, hence the small number of errors. Contributing to the few errors made by this function were the types of fodder reserve programs shown to subject 3. This subject was the first tested, and at that stage the sensitivity of the plans in some of the

programs to risk was not high, a feature that was corrected for tests on the other subjects.

The N-M model gave the worst results of all the methods. This suggests the subjects had difficulty in correctly using probabilities, even though the probabilities were expressed as frequencies in this study. Grayson [10] and Anderson [1] have commented on the problem of using probabilities in the N-M model under field conditions. It is difficult to determine precisely what factors contribute to this apparent misuse of probabilities. It could have been due to probability preferences and/or the inability of subjects to use basic elements of probability calculus. The time required for teaching subjects how to handle probabilities correctly encourages the use of other models in field studies.

Second stage

The same five farmers were involved in the second stage of the study. The aims of this second stage were to make another comparison between the criteria of utility maximization (minimization of expected disutility) and profit maximization (minimization of expected costs). Two methods were used to determine utilities—the Ramsey model and the modified N-M model, both with ethically neutral probabilities. The results of the two methods were compared to determine whether one model was clearly superior to the other. The effect of time on the subjects' utility functions, in particular the degree of risk aversion, was also examined.

Fodder reserve decisions

Ten fodder reserve programs, each representing a different farm situation, were selected from 19 programs used in the first stage. The meaning of the programs was explained in the same manner as in the first stage. The farmers were asked to decide on a particular plan for each program as though they were making the decision for their own farms.

Utility functions and predictions

The utility functions derived for the subjects, by use of both the modified N-M model and the Ramsey model, are shown in Table 4.

The decisions made by the farmers, together with the best prediction (the one closest to their decision) made by utility analysis, were marked on the fodder reserve programs and mailed to the farmers for their further consideration. Returning the results allowed the subjects to reflect on their initial decisions in their own time and negated any influence that the experimenter might have had on their decisions.

The accuracy of utility functions in predicting the farmers' decisions before the decisions were reconsidered is shown in Table 5, and their accuracy after these decisions were reconsidered is shown in Table 6.

Table 4. Utility functions for subjects

Subjects and model	Function	R ²
12	DU = 4.651592x + 0.0044781x ² - 0.0000009x ³	0.999
13	DU = 0.77160942x + 0.00013491x ²	0.998
22	DU = linear	0.999
23	DU = 0.78333569x + 0.00010586x ²	0.999
32	DU = 0.6944732x + 0.200463x ²	— ^a
33	DU = 0.2094875x + 0.0038317x ²	0.998
42	DU = linear	0.997
43	DU = 1.01909165x - 0.00006392x ²	0.998
52	DU = 3.1197489x + 0.0040217x ²	0.988
53	DU = 0.4708493x + 0.00032314x ²	0.998

^a It was difficult to get a function to fit accurately a section of the observations of utility for 32. This lack of fit caused large errors. To solve the problem, additional observations were interpolated from the freehand curve in the region of poor fit.

Table 5. Absolute errors before reconsideration of decisions^a

Subject	Minimized expected cost	Modified N-M model	Ramsey model
1	7	14	5
2	8	8	9
3	6	8	7
4	8	8	5
5	12	8	6
Errors per model	41	46	32
Average error ^b	0.82	0.92	0.64

^a The figures in the table are units of error.

^b Average error is the error per subject per fodder reserve program. There were ten programs.

Table 6. Absolute errors after reconsideration of decisions^a

Subject	Minimized expected cost	Modified N-M model	Ramsey model
1	4	13	2
2	3.5 ^b	4	4
3	10	4	3
4	4	4	1
5	14	5	3
Errors per model	35.5	30	13
Average error	0.71	0.60	0.26

^a See footnotes to Table 5.

^b A decision indicated by this criterion was indifferent between two levels of fodder reserve; since the subject chose one of these levels, the error was taken as half of one unit.

All subjects changed *some* of their initial decisions to correspond with those made by utility analysis, where the two decisions differed. All the reasons given for a change were judged to be rational [20].

Similarly, most of the reasons for not wanting to make a change were apparently rational, although it is implied that the farmers were being slightly inconsistent relative to their tested utility function. There were a couple of cases in which the reasons for not wanting to make a change were obviously inconsistent with their other decisions. It is likely that these inconsistencies could have been eliminated had they been pointed out to the subjects concerned.

After comparing the results given in Tables 5 and 6, we conclude that many of the apparent errors made by the utility models in the first stage of the study may have been due to inconsistencies in the subjects' decisions on the fodder reserve programs. The importance of being able to have some check on a subject's decisions, even for comparatively simple problems, is demonstrated, although in this stage of the study none of the corrections made by the subjects to their initial decisions were great. Utility analysis with the Ramsey model was superior to that with the modified N-M model. Subjects appeared to find it easier to make choices for the questions used in the Ramsey model. However, the Ramsey model requires more work on the part of the experimenter than the modified N-M model in deriving utilities.

Utility analysis with either model was superior to the criterion of minimizing expected cost. In fact, utility analysis with the Ramsey model gave accurate predictions 76 percent of the time. The criterion of minimizing expected cost gave accurate predictions only 58 percent of the time. Also, when the latter criterion gave a wrong decision, the wrong decision had a greater degree of error than a wrong decision given by utility analysis.

Comparisons of utility functions and decisions over a period of time

A utility function is a summary of an individual's E-V indifference system. The significance of this system is that it describes the way in which a decision maker discounts expected outcomes for the risk involved in those outcomes (Fig. 4). The slope of an E-V indifference curve (iso-utility curve) provides an index of the decision maker's risk aversion. For positive sums of money, the greater the slope, the greater the degree of risk aversion at that point (local risk aversion).¹¹ The slope of an E-V indifference curve derived from a quadratic utility function is

$$dE(x)/dV = c/[b + 2cE(x)].$$

¹¹ Pratt [22] gives the ratio of the negative of the second derivative to the first derivative of the utility function as a measure of local risk aversion; the measure is directly proportional to the slope of an E-V curve.

The slope of an E-V curve as an index of risk aversion has the following properties: (a) invariance for linear transformations of the utility function (thus, it does not involve interpersonal comparisons of utility) and (b) a measure of local risk aversion. If global inferences about risk aversion are to be drawn, the utility function must have constant marginal utilities. When this condition does not hold, if comparisons of risk aversion are to be made over a range of outcomes (risk aversion in the large), the slopes of the individuals' E-V indifference curves must be measured at a number of loci. If the same order of ranking between individuals holds for the measure at each locus, then a categorical statement can be made about relative risk aversion over the range tested. If the order of ranking changes, or the indifference curves change direction over the range, then statements about relative risk aversion can be made only with reference to specific outcomes in the range.

The measure permits interpersonal comparisons of risk aversion, that is, comparisons between individuals of predictable behavior, and also comparison of an individual's risk aversion—and his utility function—over two time periods. Table 7 gives the local risk aversion for the two stages of the study as about £800, which also reflects risk aversion in the large over the range £0 to £3,500.¹²

Table 7. Local risk aversion at £800 in the two stages of the study^a

Subject	First stage	Second stage
1	0.139	0.137
2	0.000	0.111
3	—	0.605
4	0.066	-0.076
5	0.474	0.327

^a The negative sign is dropped from the slope. The figures in the table are from the original calculations multiplied by 1,000.

These estimates of risk aversion were based on the utility functions derived by the modified N-M model for the first stage and the Ramsey for the second stage. Subject 3's risk aversion is not shown because the modified N-M model gave a completely misleading utility function for the subject in this stage.

By comparing the changes in decisions made on those fodder reserve programs which appeared in both stages of the study with those made by the utility functions, we found that the utility functions accurately reflected the direction of change in the subject's attitude to risk on fodder reserves [20]. As one would expect, these changes in attitude towards risk

¹² The ranking of local risk aversion was tested at a number of loci and found invariant over the range.

are demonstrated by the degree of risk aversion given in Table 7. The magnitude of change was not accurately reflected by the utility functions.

Conclusions and Implications

The conclusions arrived at from the empirical study are as follows:

1. The most commonly used method for deriving utilities in empirical studies, the N-M model, was found inadequate when compared with alternative models. The deficiency of the model in this study was attributed to the difficulty which subjects had in consistently assessing the frequencies used in the model. This deficiency had been noted, when probabilities are used, by other authors [18]. The persistence with which researchers working with utility analysis have adhered to the N-M model is possibly one of the reasons for the lack of confidence in utility analysis as a method of risk analysis.

2. Both the modified N-M model (with ethically neutral probabilities) and the Ramsey model (a slightly modified version of the model used by Davidson, Suppes, and Siegel [4]) gave the most accurate description of the farmers' utility functions, as reflected by the decisions using these functions.¹³ Although none of the subjects showed any apparent utility (disutility) for gambling, it is postulated that because gambling bias is likely to occur, the Ramsey model is theoretically superior. Also, the choice between two risky outcomes used in the Ramsey model is a more realistic approach than the choice between a risky and a certain outcome used in the modified N-M model.¹⁴ The farmers were, on the whole, more responsive to and showed a greater appreciation of the procedure used in the Ramsey model, although this advantage was to some extent offset by the extra questions that have to be framed in using the model. Overall, we conclude that there was little difference between the two models in this study.

3. The study showed that even for the small amounts of money involved in the operational decisions of fodder reserves, farmers had nonlinear utility functions. The usefulness of utility analysis as a decision-making aid was clearly demonstrated in the second stage of the study. The advantage of having a reference decision based on farmers' utility functions (preferences) was illustrated by the number of decisions which the subjects changed when confronted with their original decisions and those made by utility analysis. Where the two decisions were different, subjects invariably changed, for apparently rational reasons, to the decision made by

¹³ The poorer results of the Ramsey model in the first stage, compared with those in the second stage, were attributed to the lack of experience with the model at that time.

¹⁴ Although insurance decisions involve the choice between a risky and a certain outcome, there are few such decisions made by farmers. The common management decisions more closely approximate the situation of choice between risky alternatives.

utility analysis. Thus, we conclude that even for simple decisions, such as level of fodder reserve, farmers can be inconsistent and that utility analysis permits detection of these inconsistencies. The predictive accuracy of utility analysis in the simple decisions, where there is a high probability that subjects reveal the correct ordering of their preferences, suggests that utility analysis can be used for complex decisions where there is no other check on the correct ordering of preferences: thus, we are in a position to make tentative recommendations for the use of utility analysis as an aid to complex decision making.

4. Over a period of a year, it was found that farmers' decisions on fodder reserves, as well as their utility functions, did not change radically. The same situation may not exist for decisions involving larger amounts of money. One subject (subject 4) changed from risk aversion to risk preference, which was explained by his going into debt to such an extent that his equity decreased by 20 percent over the period of the drought.

A question which must arise is, To what extent are the inferences drawn from this study generally applicable? The number of participants in the study was small—five farmers. These farmers were randomly selected from a stratified group of 45 farmers. There had been no personal contact with any of the subjects before they participated in the study. There was no indication that this sample of subjects was atypical of the district—or of any other group of Australian farmers involved in a comparable enterprise mix. Thus, we conclude that until there is any contrary evidence, the benefits of using utility analysis, as found in this study, must be accepted as a guide to the general applicability of utility analysis.

Some skill is required in using utility models. It is not sufficient to construct the questions as one might for a census form. The interviewer must have the confidence of the farmer and the ability to convince him of the seriousness of the questions. The questions must be put with speed, so that the subject does not become bored, but without haste, which might confuse him. This means that the person using utility analysis must be familiar with the models and the questions.

The study has shown that utility analysis can be more successfully used than conventional economic analysis in making risky decisions. Nonetheless, there are valid criticisms of the approach. The most important is the assumption that the decision maker's goals can be reduced to a single utility function of money. Georgescu-Roegen has pointed out that this oversimplification ignores the universal "irreducibility of human wants" [9]. The approach taken here has been essentially pragmatic. The nature of the decision problem used to test utility analysis was restricted to small amounts of money (consequences), in the specific context of fodder reserves, so that the assumption of reducibility of wants was reasonably valid. Because it is unlikely that further research into the theory of utility

analysis is going to overcome the validity of such criticisms, it is postulated that the greatest returns to the theory will result from further field studies. What is required at this stage is a more extensive testing of utility analysis on a broader scale and for more diverse decision problems than in this study. Results from research in this direction should give more definitive answers to questions on the extent of the usefulness of utility analysis and also should uncover further practical techniques to augment this usefulness.

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Estimates of Potential Effects of New Technology on Agriculture in Punjab, India*

K. S. MANN, C. V. MOORE, AND S. S. JOHL

New high-yielding varieties of crops are now available in developing countries. Their potential for improving food and fiber supplies is limited by the availability of inputs such as fertilizer, irrigation, and pesticides. The effects of present, projected, and nonrestrictive supplies of fertilizer are estimated for Punjab State, India. Results indicate that large amounts are needed over and above current plan targets in order to maximize food output and farm incomes. Further, changes in price policy will be necessary to maintain production of crops where no improved-yield-potential varieties are available. Uniform allocations of scarce fertilizer supplies within a state will not maximize agricultural production and incomes.

NEW technology in the form of high-yielding crop varieties is rapidly becoming available in the developing nations of the world. Dwarf Mexican wheat, short-stemmed rice, and hybrid millets are examples of technological improvements in varieties. In past five-year plans, the government of India has placed heavy emphasis on the successful introduction of new varieties in a complete package of recommended agronomic practices. In the year 1966-67, high-yielding varieties were planted as follows: 0.5 million acres of wheat, 2.5 million acres of rice, 0.8 million acres of hybrid corn, and 0.5 million acres of hybrid pearl millets.¹ This acreage, of course, when compared to the 125 million acres of cropland in India, is nominal. By the year 1970-71, India is hoping for 8.0 million acres of wheat, 12.5 million acres of rice, and 4.0 million acres of corn, millets, and sorghum.

Punjab State, in northwestern India, has been one of the leading areas of India in the adoption and promulgation of the "package of practices" program [2, p. 265]. Farmer adoption of this new technology has been rapid; in fact, the existence of a black market in the new varieties of seed and in fertilizer indicates an unfulfilled demand for these inputs.

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The Problem

Among the crops presently planted by Indian farmers, however, there are many for which no recent improvements have been made in the genetic capabilities, primarily because of a lack of research. Cotton, peanuts, and the oilseeds are important crops in this group. Although a processing industry based on these crops has developed over the years in India and especially in Punjab, the future of such industry appears clouded because of a recent downturn in the acreage planted, especially to cotton [4].

Experimental plots and field demonstrations have furnished ample indication that the high-yielding varieties of corn, wheat, millets, and rice, when cultivated under the recommended practices, produce much higher net returns per acre than the existing varieties under the same conditions.² They also produce higher net returns than cotton, peanuts, and oilseeds. This fact suggests disequilibrium and calls for a change in the crop mix in the future if farm incomes are to be maximized.

The successful adoption of new technology in a developing country appears to be dependent upon the availability of certain vital inputs such as irrigation and fertilizer. Desirable adoptions will be speeded up by accurate advance assessment of probable effects of alternative programs. What is the potential effect which a complete adoption of the "package of practices" program in Punjab might have on the total Indian food and fiber supply? What changes in individual farm incomes and cropping patterns would accompany such an adoption? What are the major bottlenecks which might prevent a rapid and complete adoption of this program? More specifically, to what extent is adoption of this program dependent on the supply of fertilizer?

Objectives³

The foregoing questions lead to the following specific objectives of this article: (1) to determine the existing cropping pattern of farms in each agro-climatic region of Punjab State; (2) to develop optimum cropping systems for typical farms of various sizes in each agro-climatic area, under alternative conditions of technology, fertilizer, and capital supplies; (3) to establish the potential aggregate effect in Punjab of the "package of

¹ Figures are from the Indian Ministry of Food and Agriculture, New Delhi, Directorate of Extension, Dec. 1965.

² Fertilization and irrigation levels recommended for the new varieties are higher than for the traditional varieties of the same crop.

³ It would have been desirable to include as objectives the determination of price relationships which would maintain current production levels of cotton and sugarcane; however, computational facilities were not available.

practices" program in terms of cropping pattern, farm income, total production of food and fiber, and fertilizer use; (4) to determine the degree to which the rate of adoption of the total "package of practices" program depends on the availability of fertilizer.

Procedure

The state of Punjab was divided into ten types of farming regions based on the different agro-climatic conditions found by Singh and Johl [5]. Taking a large sample of the 12,891 villages in the state was financially impractical. Instead, a conference of agricultural extension officers working throughout the state was convened, and a village typical of each of the ten regions was selected, on the basis of soils, irrigation facilities, markets, and progressiveness of the farmers. A complete enumeration of the operational holdings in each of the representative villages was made. Farms were then arrayed in ascending order by size and divided into three groups—large, medium, and small. On the basis of cumulative totals along the ogive curve, the farms included in the first one-third of the total acreage were classified as small farms, the second one-third as medium, and the last one-third as large. From each size-group, 5 farms were selected at random in each representative village, or 150 farms in all. For all ten areas, the average size of operational holding was 10.7 acres for small farms, 22.6 acres for medium, and 41.9 acres for large.

These farms were surveyed. Typical farms for each size in each region were then synthesized. Budgets were prepared for the major crops grown on the typical farm in each size-group, under three conditions: (a) traditional varieties with traditional production techniques, (b) traditional varieties with recommended production techniques, and (c) high-yielding varieties with recommended production techniques.

Linear programming⁴ was used to develop normative production plans for each of the synthetic farms under different projected resource-supply situations. For the purpose of analysis, it was assumed that relative factor and product prices would remain constant for the period under study. Of course, large changes in product supplies and resource use from widespread adoption of the program could negate the results of the last assumption. This point will be considered following the aggregation of results.

⁴Linear programming to determine optimum farm plans in India has been in use for a number of years. For example, Johl and Kahlon [1] in their study of farms in Ludhiana District, Punjab, used this approach to study individual farm cropping programs in order to recommend profit-increasing adjustments. The present study is, to our knowledge, the first attempt to aggregate production changes over a wide geographic area in India.

Resource restraint

The fixed resources on the synthesized farms consisted of land with its various capability groups, labor, irrigation facilities, capital, and rationed inputs such as fertilizer and pesticides. A certain portion of the total cropland available on the farm was set aside for the draft animals maintained on the farm, and only the remainder was considered available for commercial crops. The use of this land was divided into the two growing seasons and again according to the land's suitability to grow a given crop. The supply of irrigation water available during the hot season was used as a constraint; the supply of labor during the two harvest and planting periods was similarly used.

Fertilizer is an extremely scarce resource on Punjab farms. During the year 1965-66, the availability of nitrogenous and phosphatic fertilizers was only about 8.5 pounds and 0.8 pounds per crop acre. The government's target is 37 pounds of nitrogenous fertilizer and 2.2 pounds of phosphatic fertilizer per acre by the end of the fourth Five-Year Plan (1970-71).

Programming situations

In order to estimate the impact of a new technology and the influence of the scarce resources on its adoption, we studied six assumed situations (Table 1).

Table 1. Summary of characteristics of programming situations for Punjab farms

Situation	Crop varieties	Technology	Fertilizer supply	Land, labor, & irrigation supply	Capital supply
A	Traditional	Traditional	1966 level	1966	1966
B	Traditional and high-yielding	Recommended	1966 level	1966	1966
C	Traditional and high-yielding	Traditional and recommended	1966 level	1966	1966
D	Traditional and high-yielding	Recommended	1970-71 level	1966	Unlimited
E	Traditional and high-yielding	Traditional and recommended	1970-71 level	1966	Unlimited
F	Traditional and high-yielding	Recommended	Unlimited	1966	Unlimited

Situation A.—In order to make a comparison with the present actual cropping pattern in the state, we programmed the typical farm resources,

using only the traditional technology and varieties. Fertilizer availability was restricted to the 1966 supply level. Situation A was designed to see if and to what extent the existing production plans, farm income, and aggregate supply could be improved by reallocating the present resources among the various current enterprises.

Situation B.—We included in Situation B both the traditional varieties and the high-yielding crop varieties but used only the recommended level of technology. The traditional technology included in Situation A was excluded here in order to ascertain the extent to which the improved technology could be utilized with existing fertilizer supplies. The fertilizer restriction was set at the 1966 supply level. The objective of this situation was to estimate the extent to which it would be possible to make a complete switchover to the improved technology under existing resource supplies. This situation represents an extreme condition and is included to illustrate the present very low supply of fertilizer and the high rates of use of this input required to make the new high-yielding varieties profitable. Practically and politically it is very unrealistic.

Situation C.—This situation combined (a) traditional varieties grown under traditional technology. (Situation A) and (b) both traditional and high-yielding varieties grown under recommended technology (Situation B). The results for this situation indicate the extent to which traditional technology and improved technology must exist side by side, given the current level of resource supplies.

Situation D.—In order to simulate conditions as they might be in 1970-71, at the end of the current Five-Year Plan period, we raised the fertilizer supply levels to the target levels for that year: that is, 37 pounds of nitrogen fertilizer and 2.2 pounds of phosphate per acre. We assumed, however, that there would be no significant change in the land, labor, and irrigation supply for the state as a whole. In this situation, as in Situation B, only the recommended levels of fertilizer and agronomic practices were considered. This procedure would indicate the possible results of a forced switchover to the recommended technology (including the high-yielding varieties) by the end of the plan period, without any increase in resource supplies.

Situation E.—As in Situation C, traditional varieties grown under the traditional technology and both traditional and improved varieties grown under improved technology were included in Situation E. Fertilizer remained at the projected 1970-71 level. The results for this situation indicate the extent to which the improved technology would have to coexist with the traditional technology at the end of this plan period.

Situation F.—There is great uncertainty about additional fertilizer supplies after 1970-71, and it is extremely difficult to project specific quantities to given dates. However, it was considered important to examine what

the ultimate food supply and resource use might be if fertilizer availability were no longer limiting, that is, if a small carry-over of fertilizer supplies were to exist at present price levels. In this situation, only crop activities at the improved level of technology were considered. All operating capital and fertilizer restrictions were removed. *Ceteris paribus*, the optimum cropping plans developed for each synthetic farm indicate the possible adjustments in the cropping pattern, the resultant changes in farm income, the total production of food and fiber, and the maximum quantities of fertilizer that could be profitably used in the state.

Aggregation of data

From the normative production plans calculated for the different synthetic holdings, the percentage of the total crop area of each farm which would be planted to each crop was calculated for each of the six assumed situations. An average percentage was then worked out for each crop in the state as a whole, based on the relative size of each of the agro-climatic areas delineated. On the basis of this average in a particular situation, the total acreage in the state for each crop was estimated. Production figures were estimated by using yield data collected from the survey and from conferences with university specialists working in the different areas.

Results

Situation A

A comparison of the results of Situation A (programming results based on traditional technology and current resource supplies) with the actual cropping program of the state indicates a reasonably rational existing land use pattern (Table 2). The normative cropping pattern indicated a total cropped area for the state of 11.3 million acres, compared to an actual area of 12.6 million [1]. The difference can be partially explained by a lower intensity of land use in the programmed solutions due to an assumption that only irrigated land can be double-cropped, whereas, in actual practice, a small amount of nonirrigated land, if there is enough rain, is also double-cropped.

The results found here are similar to those of Schultz [6], who defines "traditional agriculture" as an agriculture in equilibrium, undisturbed by the presence of new technology. We do not believe that agriculture in Punjab fits this definition. However, the closeness of the results for the actual situation to the optimum for this situation indicates that this equilibrium is approximated in the aggregate as the state moves out of the traditional stage.

Feedgrains occupied a major part of the acreage in this situation as they do under actual conditions. However, the normative plans included slightly more oilseeds and sugarcane than are grown in actuality. Cotton

Table 2. Estimated area, production of crops, and income by programming situation, Punjab, India

Situation	Food grains					Nongrain crops				Total area planted acres	Cropping intensity ^a percent	Average income per acre dollars
	Wheat	Corn	Rice	Millets	Other	Cotton	Sugar-cane	Oil-seeds	Other			
Actual	percentage of area											
A	30.8	9.3	5.7	3.1	16.8	9.7	2.4	4.7	19.2	12,629	133	51.73
B	28.5	7.5	2.8	3.2	15.2	9.0	5.1	6.2	20.7	11,265	117	52.67
C	1.3	—	0.4	13.9	29.1	—	0.3	16.0	39.0	5,835	58	22.93
D	19.8	7.1	3.4	6.5	21.3	8.3	2.5	10.0	20.8	11,064	115	55.33
E	27.3	2.2	0.3	23.8	15.5	0.4	1.7	9.6	19.2	11,160	116	82.26
F	23.6	7.0	2.7	16.0	15.3	7.5	2.9	8.0	16.5	13,373	139	99.33
	24.8	10.3	1.4	33.8	11.9	—	0.9	1.9	15.0	14,912	155	162.53
Actual	production, thousand tons											
A	2,360	488	351	61	732	146	444	215	—	—	—	—
B	2,130	541	160	55	549	122	874	242	—	—	—	—
C	46	—	26	491	2,394	—	54	561	—	—	—	—
D	1,392	406	186	408	1,285	111	407	315	—	—	—	—
E	4,300	278	40	1,597	1,220	14	570	664	—	—	—	—
F	4,118	669	177	2,305	1,189	123	780	567	—	—	—	—
	8,216	3,072	564	6,912	1,310	—	402	179	—	—	—	—

^a Cropping intensity is defined here as acres of crops planted expressed as a percentage of acres of cropland available.

acreage was lower in the programmed solution, although it was still a very important crop in the cotton-growing region of the state. Farm incomes under the normative solution were only slightly higher than incomes budgeted for the sample farms based on their actual cropping system.

Under the existing technology, nitrogenous fertilizers constituted the major restraint. The use of phosphatic fertilizer in the form of superphosphate was not very common, according to the farmers interviewed; however, its introduction has been fairly recent. The normative solutions for this situation used the entire quantity of nitrogenous fertilizer available.

Situation B

Throughout India there is a great deal of enthusiasm over the new high-yielding crop varieties and a strong desire to extend them to the farmers as rapidly as possible. In the progressive agricultural areas, the demand for improved seed has reached a point where farmers are willing to pay large premiums for a small seed sample. Agronomic and economic studies have shown, however, that if improved seeds are not accompanied by higher levels of fertilizer, pesticides, and irrigation, there is a strong possibility that farm income will decrease instead of increasing.

Situation B was designed to discover what might happen if there were a *forced* changeover to the improved technology without a commensurate augmentation of farm resources. Therefore, only crops grown under improved technology and agronomic practices were considered in this program. Land, labor, capital, and fertilizer were set at the present level of availability.

The solutions to these programs indicated that forcing immediate complete adoption of the recommended technology would cause a severe misallocation of resources with a concomitant decrease in farm incomes throughout the state. Food grain acreage would drop from 64 percent of the total cropland to about 44 percent. The acreage planted to wheat (Punjab's most important crop) would all but disappear (Table 2). Only those crops which used small amounts of fertilizer would be grown, and large areas would remain idle. The intensity of land use would drop from the present level of 133 percent to about 58 percent, so that 42 percent of the land would go unused the year around.

Average returns over variable expenses per acre would drop from about Rs. 388 (\$51.73) to about Rs. 172 (\$22.93). In this situation, available irrigation would be underutilized during the normal peak periods. Solutions to the programs favored nonirrigated crops because of their low requirements for fertilizer. The normative cropping plans used all of the available nitrogen fertilizer.

It would appear from the solution for this situation that an immediate complete switchover to the recommended technology at this time would hinder the Indian government in moving toward its goal of self-sufficiency in food. Further, with the present availability of fertilizer, adoption of the high-yielding varieties would reduce total farm incomes. The analysis of this situation may provide a partial explanation of why farmers throughout the state have not completely adopted the recommended package of practices.

Situation C

From the previous situation, it appears that at the present time the traditional technology must exist side by side with the improved technology. Situation C, therefore, was designed to indicate to what extent this coexistence must occur with the current level of input availabilities.

The total cropped area under the conditions of this situation would be about 11.1 million acres, compared to the actual acreage of 12.6 million. The difference would result chiefly from a decrease in the acreage of food grains, but a drop would also occur in cotton and sugarcane acreage (Table 2). Under this set of assumptions, the cropping intensity was 115 percent. This is almost twice the intensity found in Situation B but still about 18 percent below the actual intensity.

The increased intensity of land use over Situation B would bring a commensurate rise in farm incomes. Average returns over variable expenses per acre would be considerably above Situation B and slightly above (Rs. 27.00 or \$3.60) the budgeted farms included in the survey for this study.

Fertilizer would be, as expected, the factor most limiting to increased production in this situation. The normative plans used the entire amount of nitrogen and phosphorous available in all the agro-climatic regions of the state. Although it would be possible for some of the land to be shifted to crop enterprises using the recommended technology, the bulk of the land would remain under the traditional technology—a better alternative than allowing the land to remain idle because of the shortage of fertilizer.

Situation D

The situations analyzed thus far have restricted fertilizer and other scarce inputs to presently available quantities. However, during the present Five-Year Plan, efforts are being made to increase the fertilizer production capacity of the country in both the public and the private sectors of the economy. Plan targets for the crop year 1970-71 are 37 pounds of actual nitrogen and 2.2 pounds of actual phosphorous per acre of cropland in the state of Punjab. To assess the impact of these expected higher resource levels and to simulate conditions that might prevail at the end of

the current Five-Year Plan if a complete changeover to the recommended levels of fertilization and other practices were made, we calculated normative solutions under the following conditions: Labor, land, and irrigation were set at the current levels. The cash restraint was removed and fertilizer levels were set as indicated above.

Normative cropping patterns calculated under these conditions indicated a total crop area for the state of 11.2 million acres, which would be still somewhat below the present level. Food grains would increase in proportion to the total to about 5 percent above the present level. Cotton acreage would decrease most, with only about one-third of the current acreage being planted (Table 2). Land use intensity would be about 116 percent, which is still below the existing level. However, this intensity, which is considerably above the results of Situation B, indicates quite clearly how essential increased fertilizer supplies will be to a rapid adoption of the new technology. Even at the 1970-71 level of availability, fertilizer will constitute the principal restraint to production and land use.

Net farm incomes in this situation would increase to a considerable extent at current price levels. The increased supply of fertilizer would allow net returns to increase to Rs. 617 (\$82.26) per acre, compared to actual returns of Rs. 388 (\$51.73). The productivity of fertilizer at this point would still be quite high.

In almost every region of the state, all available fertilizers would be used. Normative cropping plans indicate that in this situation, the fertilizer supply would be a critical input and would exert an even stronger influence on cropping patterns at the end of the fourth Five-Year Plan in Punjab. Even at the increased level of fertilizer expected by the end of the plan, the normative plans included planting only about 10 percent of the cropland to the new high-yielding varieties. The remainder would be planted to existing varieties, but recommended agronomic practices would be followed.

Production estimates for this situation emphasized the high productivity of fertilizer on food grains. Output of food grains in Situation D was calculated to be almost double the actual output in 1964-65. Cotton, on the other hand, because of the sharp decline in acreage, would reach only 90 percent of current production.

Situation E

Conditions comparable to those likely to prevail at the end of the current plan period were assumed in Situation E. Crops considered were grown under traditional as well as improved technology and included the high-yielding varieties. Fertilizer supplies were assumed to be the target levels for the year 1970-71, as in Situation D. Under these conditions, as in Situation C, some estimate can be made to indicate the degree to

which traditional technology must be retained alongside the recommended technology and high-yielding varieties.

Total cropped area in this situation was estimated at 13.4 million acres, compared with the current figure of 12.6 million acres. The area planted to food grains would be 8.69 million acres, compared to 8.0 million in 1964-65 (Table 2). Acreage increases in Situation E over those in Situation D are primarily due to allowing crops grown under traditional technology to come into the program. Cotton acreage would be higher than in Situation D but would still fall below the 1964-65 levels. The intensity of land use would be 139 percent, which is higher than in any of the other situations studied thus far and higher than the present actual intensity of use. In areas with a higher proportion of irrigated land, the intensity of land use would be comparatively higher.

Production and incomes would increase with the greater utilization of improved technology and a higher land use intensity. The aggregate estimate of food grains under this situation was 8.5 million tons, compared to the 1964-65 production of 4 million tons. Average returns over variable expenses per acre would rise to Rs. 745 (\$99.33), which is nearly twice the existing level of income.

The normative production plans under this set of conditions did not indicate that the presently available irrigation supplies would be unduly restrictive in 1970-71. However, it must be kept in mind that yield figures assume a normal rainfall in both the monsoon and the winter season and years with below-normal rainfall would demonstrate the inadequacy of the existing irrigation capacity.

Under the conditions set forth in this situation, it would not be possible to extend the recommended technology to more than about 48 percent of the total cropped area, including 15 percent planted to high-yielding varieties. Therefore, at the end of the current plan period, the economic planners could, at best, hope for the recommended agronomic practices to be used on only about half of the crop area. Traditional technology would still be used for a large proportion of planted acreage.

Situation F

Since concerted efforts are being made to increase fertilizer supplies in India, it is logical to assume that at some time in the future the amount of fertilizer available will approach a free market equilibrium. Situation F was formulated to assess what the cropping pattern and production of major crops might be at that time. This task was accomplished (with certain reservations) by relaxing the fertilizer restraint completely. The operating capital restraint was also removed but the other restrictions previously imposed were retained.

The cropping pattern that maximized returns to fixed farm resources in this situation indicated that major shifts away from the present cropping pattern would occur. The total cropped area for the state would increase to 14.9 million acres, which is 2.3 million more than the current cropped area. All of this increase would be due to a higher utilization of the present land area through double-cropping, not to an increase in arable land being brought under cultivation. Food grain acreage as a whole would increase over 50 percent above the actual (Table 2). The largest increase would occur in the acreage planted to millets because of the high returns expected from the hybrid varieties even without irrigation. Cotton, however, would disappear altogether from the cropping pattern, and sugarcane and oilseeds would decrease 9 and 7 percent, respectively.

Solutions to the problems in this situation indicate a complete shift to the high-yielding varieties of corn, rice, and millets. In the case of wheat, the entire irrigated area would be planted to the high-yielding varieties; the nonirrigated area would be planted to traditional varieties, but recommended agronomic practices would be used. Intensity of land use is linked with the irrigation facilities available: except in areas of heavy rainfall, double-cropping is not feasible without irrigation. In this situation, the land use intensity would be 155 percent. Any increase over this intensity would require additional irrigation facilities in the form of additional wells or major stream diversions.

Average returns over variable expenses were estimated at Rs. 1,219 (\$162.53) per acre, three times the present average returns. These higher returns, however, would require substantial increases in operating capital. Average capital requirements were estimated at Rs. 245 (\$32.67) per acre, a little more than a 50-percent increase over the present available supply, which was estimated at Rs. 152 (\$20.26) per acre. Obviously, at this point, lack of credit could become a serious impediment to adoption of the "package program."

The average requirements for fertilizer in this situation were calculated to be about 124 pounds of actual nitrogen and 63 pounds of phosphorous per acre of land. There was, however, considerable variation among the different agro-climatic regions of the state with respect to utilization of fertilizer, indicating that even in a state as small as Punjab, a uniform allocation per unit of area would not maximize output and farm incomes.

The estimates of production in this situation indicate the possibility of spectacular increases in the production of food grains, particularly wheat and millets. Total production of food grains would be about 20 million tons, compared to 4 million tons in 1964-65. The difference would about make up the current food grain deficit in India. However, with the current rate of growth in India's population and real income, by the time the

fertilizer, seed, and other scarce inputs needed to meet the conditions of this situation are available, the need for additional food grains will have risen considerably. Part of this increase in food production would come at the expense of cotton, sugarcane, and oilseed production. All of these crops are important raw materials for industry and significant foreign exchange earners and will have to be carefully considered in any future price policy.

Conclusions

The results of this work indicate the important future role of the high-yielding varieties in increasing the production of food grains in developing countries. It has been demonstrated that the fertilizer supply will likely be a very critical factor in influencing the adoption of the high-yielding varieties for a number of years in the future. This study estimates the effects of fertilizer availability restraints at different levels. High-yielding varieties by themselves are not a panacea for the production ills of food-short nations. As fast as one problem is solved, a new one appears: the problem of fertilizer supply gives way to the problem of credit, and so on. Of course, we have not discussed in this article the problems of marketing, storing, and distributing any increase in production.

The most severe limitation to this study is the assumption that relative prices remain constant over the course of time. As the production of cotton, sugar, and oilseeds continues to decline, heavy pressure will certainly be brought to bear on the central government to alter the price structure for these commodities, and the conclusions of this article will have to be modified accordingly. Furthermore, aggregation of micro units to obtain state production estimates also causes errors of an unknown magnitude in the results.

Despite these shortcomings, the results of the research reported here are of importance. The programming results give evidence that the potential contribution of any single improvement in techniques towards increases in production and net incomes of Indian farmers is rather limited. Large quantities of fertilizer, in excess of current planned target amounts, are needed to maximize food output and net farm incomes from production of new high-yielding crop varieties. This finding is significant, because the models used included the assumption that farmers would pay the estimated competitive market price for all fertilizer used. Changes in product price policy are necessary to maintain levels of production of crops for which improved yield varieties are not available. Finally, if fertilizer supplies are very scarce, as in present-day India, nonuniform allocations depending upon types and varieties of crops grown and techniques used are necessary to maximize production and net incomes.

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"Subsistence Agriculture": Analytical Problems and Alternative Concepts*

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This article argues that the concept of "subsistence agriculture"—widely encountered and long used in the literature—is not meaningful enough to be analytically useful as usually employed and should be abandoned. Particularly important for policy is the fact that use of the term "subsistence agriculture" leads to implicitly treating all small-scale agriculture as a homogeneous residual made up of producers who vary little in their potential contribution to economic development. Data are presented which strongly suggest that small-scale agriculture in less-developed countries is not homogeneous so far as decision-making situations are concerned. The second half of the article considers development of an alternative set of criteria for classifying small-scale farmers that would reflect meaningful differences in decision-making experience and decision-making situations. A tentative set of such criteria for which data are now available, or could be developed with relative ease, are presented to illustrate the relevance of such a classification for development planning and policy.

SMALL-SCALE agriculture is often the sector of developing economies that presents the most difficult development problems, and central to efficiently changing the productivity of this sector is an understanding of the prevailing patterns of decision making and the potential for changing them. New inputs (for example, fertilizers, improved seed, and pesticides) need to be provided and situations created such that small farmers will decide to use them; new economic activities and techniques need to be tested and disseminated by means that will maximize the rate of their adoption; and decision makers in rural areas need to be encouraged to react constantly to available resources, techniques, enterprises, and consumption possibilities in ways that are favorable to the needs of an expanding and developing economy.

We know little as yet about the kinds of situations needed to induce farmers to use new inputs. We particularly lack understanding of rural decision making and decision-making situations and of how they vary from area to area. If there are substantial differences in the patterns of decision making among small-scale farmers—because of differences in the resource situations, say, or because of institutional restrictions faced—we need not only many more data but also better concepts and tools than are now available if we are to identify and analyze these differences.

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Currently, national planners and students of economic development have a strong tendency to give little attention to decision making among small-scale producers; they not infrequently recommend policy measures which transfer most or all decisions on agricultural production from small farmers to others¹; and they seem rarely to recognize differences in the character of decision making among small-scale producers of a particular country, or from country to country.

The purposes of this article are (1) to argue that the failure to give attention to differences in decision making among small-scale farmers of developing countries is caused by the vagueness of the popular system of classifying such farmers, (2) to present data that suggest considerable differences in the decision-making situations of small-scale farmers in the less-developed countries, and (3) to discuss development of a set of criteria for classifying small-scale farmers in developing countries according to their decision-making experience and the decision-making situations which they face.

Current Classification of Farmers in Developing Countries

Less-developed economies are divided into a "modern" sector or sectors, often referred to as the "foreign enclave" or the "money economy," and a residual that is frequently almost entirely agricultural and usually called "subsistence agriculture," although Enke recognizes a third "native market economy" between the foreign enclave and what he calls the "subsistence sector" [10, p. 29]. Sometimes distinctions are made between pure "subsistence" producers and producers who have both "subsistence" and non-"subsistence" production, but such producers are nearly always identified as part of the "subsistence" sector.² This lumping together occurs

¹ One well-known example, because it is one of the few financially successful agricultural development projects in Africa, is the Gezira scheme for cotton in the Sudan, in which the Sudanese farmers in effect supply labor, and foreign investors and the government provide capital and management [11]. Another example is the "satellite" system of production by which farmers around a processing plant receive all non-labor inputs from the processing firm and carry out all field operations under its supervision, found for pineapples and tobacco in the Ivory Coast, for palm oil in Cameroun, for sugarcane in parts of Mexico, and for sugar beets in Chile. Similar control of techniques of production is found for some crops financed by the government Ejidal Bank in Mexico, although the producer is left free to sell his crop wherever he wishes.

² An exception is C. R. Wharton, Jr., who distinguishes four types of subsistence producers and makes use of the concept of "semi-subsistence" producers, although he does not define this term well enough to identify such farmers empirically [33, pp. 49-50]. Wharton and Myint both distinguish between a "subsistence" level of living and "subsistence" production, the latter defined in terms of the percentage of production sold, whatever the level of living [33, pp. 47-48; 25, pp. 43-44]. The richest body of materials on "subsistence" agriculture is the collection of unpublished papers presented at the Agricultural Development Council's seminar on "Subsistence and Peasant Economies," held February 28 to March 6, 1965, at the East-West Center, Honolulu, Hawaii. A number of the authors of these papers give some criti-

largely because of the difficulty of establishing precise degrees of "subsistence" production, as typically defined, and apparently also because of the common, but demonstrably questionable, assumption that for purposes of analysis there is little difference between producers with a high proportion of "subsistence" production and those with a low proportion—that the important distinction is between *some* "subsistence" production and *none*.

The argument advanced here is that the kinds and numbers of decisions which must be made by producers at one end of the "subsistence" scale are vastly different from those made by producers at the other end and *can* be much different for two producers with the same proportion of "subsistence" production.

Definition of "Subsistence" Farmers

The level of consumption, the proportion of production marketed, the motivations that prompt farmers to produce output to be marketed, and the rate of change of production techniques are all used in the literature in varying combinations to define "subsistence" farmers.³ In discussions of problems of economic development, one of the concepts related to the nature of production—frequently simply the proportion of production marketed—is usually implied. The least ambiguous and analytically most useful concept is pure "subsistence" defined as complete self-sufficiency by the individual or the household. If pure subsistence prevails, production techniques can change some, with introduction of new crops or tools, for instance—and such innovations may result in output increments that are large relative to the existing level of production—but it is unlikely that there will be frequent or continuous changes in technology. It will be impossible to improve efficiency significantly through specialization, and it will be difficult for knowledge and matériel needed for increases in productivity to flow from one producing unit to another. Moreover, producing units will be cut off from external pressures and incentives for increases in productivity.

Once farmers begin to sell or barter output, distinguishing between them becomes difficult conceptually and often impossible empirically. Hence, it is not surprising that we have no common scale for measuring degrees of subsistence and that in practice all small farmers with any production that is not sold tend to be called "subsistence" farmers.

cism of the way in which the concept of "subsistence" has been used, but none of them seems fully to recognize the hazards in continuing to use this concept and none recommends scuttling this concept for a more precise classification of farmers in developing countries.

³ See a United Nations publication [32, pp. 1–3] for a discussion of "subsistence economies" in Africa that employs all three of these criteria.

Analytical Problems with the Concept of "Subsistence" Farmers

It is questionable that any "subsistence" concept other than pure subsistence is meaningful enough to be useful in economic analysis. A farmer who sells some of his produce in four out of ten years and none in the other six, averaging, say, 20 percent a year, is not a "subsistence" farmer to the same degree as one who sells 20 percent of his produce every year. And both are different, for purposes of analysis, from a farmer who sells 40 or 60 percent of his produce each year.

Presumably a farmer who, over a ten-year period, sells 70 percent of his output, on the average—but who planned to sell only 40 percent and was able to sell more because unexpectedly good weather resulted in a large surplus in a few of the years—should be thought of as nearer to pure subsistence than a producer who planned to sell 80 percent of his output but because of poor weather sold only 70 percent. As yet, however, we have no way of relating degrees of "subsistence" to the relative amount marketed, to the variability of the percentage of production sold, or to the proportion of production which farmers plan to sell.

Even if an index of the degree of "subsistence" could be developed, it would not tell us much about decision making. None of the variables involved in the concept of "subsistence" producers distinguishes unambiguously among farmers according to their decision-making behavior or the nature of the decision-making situations which they face.

Attitudes toward risk

Two farmers who sell the same proportion of their production with the same regularity may respond quite differently to a new economic activity or a new technique because one of them may be closer than the other to either his minimum physiologic level of living (MPL)⁴—that is, the minimum level of consumption necessary to maintain life—or his minimum desired level of consumption (MDL)—that is, the minimum level of living he feels that he is expected to attain. Thus, the minimum *physiologic* level of living⁵ is fixed for any given group in a given environment, while the minimum *desired* level is elastic and largely culturally determined.

Suppose that two farmers sell the same percentage of production, with one of them twice as far above the minimum physiologic level of living as

⁴ Wharton uses the same term but defines it somewhat differently [33].

⁵ The minimum physiologic level of living is much lower than most people assume. The minimum yearly food budget was only \$59.88 in August 1944 in parts of the United States, according to Stigler's calculations [30, pp. 303–314]. M. K. Bennett estimates minimum food costs to have been \$136.50 per annum for Palo Alto, California, in January 1953 [3, pp. 130–131]. In much of the tropics the minimum physiologic level of living is probably much lower than in the temperate zone because less food is required to provide body warmth and because little or no clothing and shelter are required to maintain life.

the other, but with neither yet near the minimum desired level of living. Given an opportunity to try a new enterprise or technique, the producer nearer the minimum physiologic level of living will be less likely to accept it because a smaller loss is required to take him below his MPL (Fig. 1).⁶

Given the same situation except that the producer with the higher level of consumption (Producer B in Fig. 2) exceeds both his MPL and his MDL whereas the other (Producer A) exceeds only his MPL, the difference in the probability of acceptance of a new enterprise or technique may be reversed because neither farmer believes that he is likely to be reduced to his MPL by his decision, and since Producer A has not yet reached his MDL, his desire to attain it constitutes a stronger incentive than Producer B's desire to add to the margin above his MDL which he already enjoys.

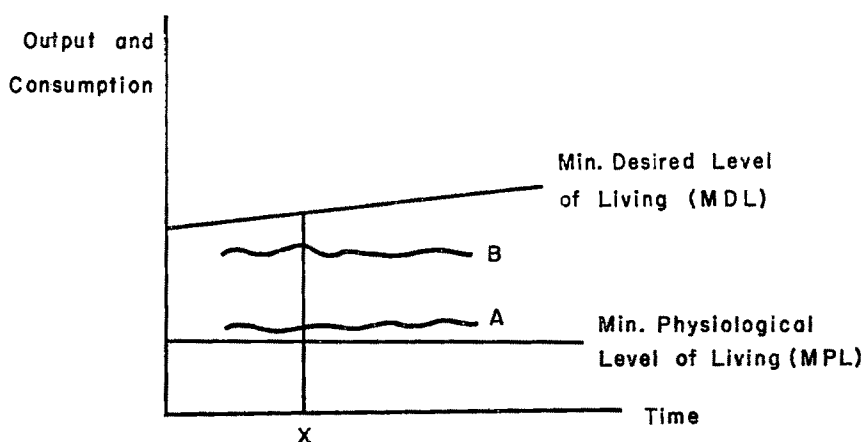


Figure 1. Example of two producers, each of whom produces more than the MPL and less than the MDL, but with different levels of production

Similar results might occur in the first case (both producers below MDL) if the maximum expected loss from the new venture were not large enough to reduce the farmer with the lower level of output (Farmer A) to his MPL.

⁶ Hla Myint argues that the striking difference in the response of "subsistence" farmers to opportunities to grow export crops may be explained largely by situations something like the one suggested here [25, pp. 44-45]. He argues that producers near the "subsistence level of living"—he does not indicate whether he means what is called here the minimum physiologic level of living or the minimum desired level of living, or something else—are reluctant to bear the risk of an export crop.

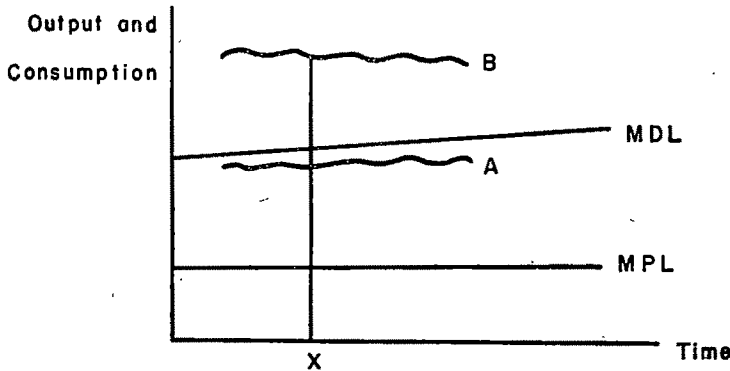


Figure 2. Example of two producers, each of whom produces more than the MPL, but one produces more than the MDL and one less

Kinds of decisions to be made

To classify small-scale producers by percentage of production sold is to take account only of selling behavior; in actual fact, two farmers with exactly the same percentage of production sold may well face greatly different decision-making situations because of differences in their reliance on purchased inputs. For example, a farmer who has inherited as much land as he can manage, and who has a relatively large and efficient family labor supply to use on it, may sell 60 percent of his production and buy no inputs, whereas a neighbor with little family labor and no land of his own may also sell 60 percent of his production and purchase more than half of his inputs. In fact, if we are going to limit ourselves to a single criterion for classifying farmers in developing countries, it might be argued that dependence on the market for purchase of inputs is a better criterion than dependence on the market for sale of output and purchase of consumption goods.

The nature of decision making can vary greatly because of differences in (a) the length of the lag between decisions and output, (b) factor proportions, and (c) access to resources. The major staple food crops grown in tropical countries have widely varying growth periods: as short as two months for some varieties of maize (called corn in the United States) and the millet-sorghum group; as long as 18 months for some varieties of taro and plantains; and even longer for some varieties of manioc (up to 24 months), breadfruit (often 60 months), and sago palm (as much as 180 months). Even among farmers growing only annuals, those who can grow two or three crops a year on the same plot make decisions more frequently and can change their farming methods more rapidly than those with a single production cycle per year.

The combination of crops grown also affects the complexity of deci-

sions to be made. Farmers with some enterprises which contribute substantially to production in others (for example, livestock providing fertilizer for crops, crops grown partly or entirely as livestock feed, legumes grown because they help raise the nitrogen content of the soil, and maize or sorghum that serves as support for climbing beans or for yams) have more complex production decisions than those without strong complementarities between products, or between products and joint- or by-products, to consider.

S. C. Hsieh reports that in a sample of 50 small farms in the Chupei Hsiang and Hsiangshan Hsiang areas of northern Taiwan, 43 percent of the farmers raising hogs raised them mainly for the manure they produced, and 48 percent of those growing sweet potatoes grew them for animal feed [14, pp. 7 and 14]. Yet in most of tropical Africa and parts of Latin America, no feed is produced for livestock and animal manures are not utilized.

Factor proportions are sometimes vastly different. Capital is short throughout small-scale agriculture in underdeveloped countries, but in some farming systems the limiting factor is land (for example, irrigated rice) and in others it is labor (for example, any of the various systems of shifting cultivation). The nature of property rights varies, from systems where land is used but not owned by individuals and is allocated by some tribal authority, to sharecropping and freehold. The magnitude of variation in decision-making situations that can be found within small-scale agriculture in developing countries is illustrated in Table 1, which presents some comparative data on the proportion of land rented or leased, incentives for improving land, and the proportion of nonfarm labor in the farm labor force.

As Table 1 shows, what are now called "subsistence" farmers do not necessarily cultivate family farms. They may obtain labor outside the family—some small-scale farmers hire much of their labor—and the size of the family labor force can vary considerably, not only because of differences in family size, but also because of variations from one social system to another in labor obligations of particular family members. Variations in labor obligations are especially important where polygyny is practiced and wives owe their husbands a certain amount of labor, as in much of tropical Africa.

It is true that savings and capital accumulation are small by Western standards, but so is the level of production. The percentage of production saved may be noteworthy, and the importance of both saving and hoarding may vary greatly from one rural economy to another without there being much visible evidence. Variations in the availability of capital goods suggest large differences in absolute amounts saved. So-called "subsistence" agriculture contains both farmers with no draft power (that is,

Table 1. Variations in some characteristics of small-scale farm operations in selected areas

Area	Nonfarm labor as percentage of total labor ^a	Land rented or leased as percentage of total ^b	Incentive to improve land ^c
Latin America	.....percent.....		
Buerarema Município, Bahia, Brazil, 1966 ^a	48	5	Strong
Garanhus Município, Pernambuco, Brazil ^b	8-19 ^c	6	Strong
Jamaica, 1954-55 ^d	17	8	Strong
Africa			
Agricultural Fulani ^d	0	0	None
Cocoa farmers, Bongounou, Ivory Coast, 1955-56 ^e	22	—	Developing
Cocoa farmers, Akokoaso, Ghana, 1933 ^f	12	—	Developing
Cocoa farmers, Nigeria, 1951-52 ^g	41	14	Developing
Northern Sudan, 1964-65 ^h	50 ^g	23	Strong
Southern Sudan, 1948-1951 ⁱ	0	0	None
Eastern Uganda, ^j	—	—	Strong
Western Uganda, 1951 ^k	—	—	None
Zambia			
Unga, 1942-1944 ^l	0	0	None
Bemba, 1933 ^m	0	0	None
Luvale, 1959 ⁿ	0	0	None
Plateau Tonga ^o	20 ^c	—	Developing
Gambia, 1947-1949 ^p	31	0	None
Ethiopia, 1963 ^q	33	—	Strong
Asia			
Northern Taiwan, 1961 ^r	0	40	Strong
La Union Province, Philippines, 1960 ^s	—	23	—
Mainland China, 1929-1933 ^t			
Yangtze rice-wheat area	14	39	—
Rice-tea region	13	42	—
Szechwan rice area	23	49	—
Double-cropping rice area	9	47	—
Southwest rice area	19	27	—

^a Data are from a random sample of 175 farmers with 20 hectares or less of cocoa, taken in January 1966. By use of a table of random digits, I drew 25 farmers, 22 of whom were in the município during the week of interviewing and were interviewed. Labor estimates are rough estimates derived from answers given by farmers to questions about how many laborers they hire and how many family workers are regularly employed.

^b Data are derived from a survey of 13 small "family" farms [15, p. 476].

^c Edwards [9, pp. 70, 99, 142].

^d Based on information given to me in July 1965 by Fulani informants in Upper Volta and Mali. See also Murdock [24, pp. 413-420].

^e Boutillier [5, pp. 57-61 and 69-73].

^f Beckett [2, pp. 56-63].

^g Galetti *et al.* [12, pp. 132-160 and 668].

^h Data from an unpublished study by L. A. Witucki, University of Wisconsin, of 104 small farmers between El Debba and Karima in northern Sudan from June 1964 to February 1965.

ⁱ De Schlippe, [8, Chaps. 4 and 5].

^j Mukwaya [23] and Wrigley [35]. Data are for the Ganda.

^k Winter [35]. Data are for the Bwanba of extreme western Uganda near the southern edge of Lake Albert.

neither beasts of burden nor machines) and no tools other than simple knives and hoes, and farmers with animal-drawn steel plows and fairly elaborate irrigation systems.⁷

The current practice of using the term "subsistence" in such a way as implicitly to classify the majority of farmers in developing countries as having the same economic restraints and development potential is, then, unnecessarily crude and misleading. There must be some way, through additional research, to develop a better system of classification, one which will make it possible to plan and direct development more effectively.

¹ Brelsford [6, Chap. 10.]

^m Richards [28].

ⁿ White [34, pp. 17-53].

^o Rees [26, pp. 10 and 16-17]. Data are from a random sample of 112 farmers participating in a scheme to improve African agriculture.

^p Haswell [13, Chap. 2 and p. 134].

^q Miller and Makonnen [17]. Data are from three "typical" farms of the Harar-Highland area of Eastern Ethiopia.

^r Hsieh [14]. Data are from a study of 50 farms.

^s 1960 Census of the Philippines [27, pp. 25-26]. Data are for La Union Province.

^t Buck [7, pp. 194 and 293].

^u Labor paid for in commodities or in rights to use of land and that obtained by exchange of labor for labor are included in nonfarm labor.

^v The lower figure applies if part-time laborers are excluded, the higher figure if all part-time laborers are assumed to work as much as permanent laborers. Both figures are underestimated by an undeterminable amount because available statistics report only total family size—not hours worked—and these calculations were made by assuming that all family members, even children, worked as much as hired labor.

^w Fifty-six percent of farmers hired labor, but the total number of hours worked by nonfarm laborers is not known.

^x The percentage of the total labor force. The number of hours contributed by nonfarm laborers is somewhat lower because some nonfarm laborers work only seasonally.

^y Land worked by a farmer who owns it jointly with others is counted as land owned.

^z Where land can be individually owned, the incentive to improve it is called *strong*; where individual ownership is not yet common but is increasing, incentive is classified as *developing*; where only communal land tenure exists and there is as yet no strong erosion of traditional land tenure, the incentive to improve land is labeled *none*.

⁷ There are still other differences in the characteristics of small-scale farming which, granting certain assumptions, can cause farmers with a given degree of market orientation to face different decision-making situations. Assuming that changes in the composition of output marketed are dictated mainly by response to economic incentives, and that the resource base and access to all factors of production are the same, we may expect that a farmer who on the average sells 60 percent of his produce but sells mainly commodity X in some seasons, Y in others, and Z in still others will be more receptive to a new crop or technique than a neighboring producer who likewise sells 60 percent of his output, on the average, but always sells the same commodity. Similarly, a farmer with a given degree of market orientation generated by five enterprises—even if he does not change the composition of the product mix sold from year to year—is likely to be more receptive to innovations, other things being equal, than a neighbor who achieves the same market orientation with a single crop—that is, a producer selling 60 percent of five crops will be more receptive than a producer selling only one crop and selling 60 percent of it.

Toward Development of a Classification of Small-Scale Farmers According to Decision-making Situations

Decision-making behavior of small-scale farmers has not been measured in most underdeveloped countries and is difficult to assess in detail. We do have some data, however, on differences in decision-making situations faced by small-scale farmers, and it may be possible to distinguish situations which are relatively favorable to economic change from those which are unfavorable.

This section suggests seven criteria for which reasonably reliable data now exist, or can be developed, in underdeveloped countries, criteria that reflect meaningful differences in past decision-making experience and current decision-making situations (that is, differences that are meaningful for policy measures designed to increase the output or productivity of small-scale farmers). These criteria are presented to demonstrate that for development planning there are several aspects of a small-scale farmer's behavior that are far more meaningful than the proportion of his output which he sells. The relative value of each of these criteria in identifying decision-making environments that are relatively favorable for the success of a given policy measure needs testing; there may be other criteria that should be added; and there may be additional divisions and subdivisions within these criteria^a that should be recognized.

Here, then, is a suggested list of criteria for classifying small-scale farmers in developing economies:

1. Extreme isolation.
2. Chronic low level of living.
 - 2.1 Chronic malnutrition traceable to the level of production.
 - 2.2 Fairly frequent occurrence of seasonal food shortage.
3. Economic stagnation.
 - 3.1 Little increase in per capita production in the last ten years.
 - 3.2 Little increase in production sold per capita.
4. Weak commitment to agriculture.
 - 4.1 Off-farm activities outside of agriculture and commerce.
 - 4.2 Off-farm activities in commerce or elsewhere in agriculture.
5. Insecurity of land tenure.
 - 5.1 Insecure land tenure discourages land improvement.
 - 5.2 Insecure land tenure restricts enterprise combinations.
6. Labor dependency.
7. Capital dependency.

^a These criteria are not meant to be mutually exclusive.

Extreme isolation

It is of interest to identify groups within small-scale agriculture that are extremely isolated from agricultural innovations. Extreme isolation is clearly a condition of pure subsistence farmers—indeed, extremely isolated farmers are probably the only group to which we should apply the term “subsistence.” Extreme isolation is probably also a condition of farmers who have extremely high transportation costs, whether or not they are completely self-sufficient. I would argue that farmers without bicycles, water transportation, or beasts of burden, who are more than five miles from the nearest market place or store, would usually be in this category.⁹ Even if they are occasionally visited by peddlers or by commodity buyers who have means of reducing transportation costs, such contacts are not as likely to add to the farmer’s knowledge of ways to increase output or productivity as are regular visits to sites where others besides himself are buying or selling. Also, isolated farmers will be visited much less frequently by extension agents and others attempting to change agriculture than farmers who are relatively accessible.

Chronic low level of living

In any country there are farmers who are chronically unable to produce enough to maintain minimum consumption standards set by society. Thus defined, this category would include some farmers everywhere, but many of their characteristics might be different from country to country at any point in time, and different from one time period to another in the same country. The fact that the production performance of such farmers is chronically below standard means that they are likely to face more production restraints—or more severe restraints—than other small-scale producers; and, in any event, it seems clear that a different set of policy measures is required to increase their contribution to economic development. Probably any group which suffers from conspicuous malnutrition traceable to inadequate production can be put in this category.

Reliable information on nutritional status is not available for most farmers in the less-developed countries, but where nutritional data are lacking there may be data on seasonal food shortages. Large groups in the drier savannas of tropical Africa reportedly suffer preharvest hunger fairly frequently because of the irregularity of rainfall [21, pp. 36–48] and the same may be true of similar climates elsewhere.

Economic stagnation

Groups of small-scale farmers have strikingly different performance in terms of (1) the rate of growth of per capita production, (2) the level of

⁹ In mountainous areas, the same degree of isolation may exist even where farmers are closer to a farm marketing center.

per capita productivity, and (3) the growth of production for the market; and in many areas the data needed for measurement of the last two are either fairly widely available or else probably could be collected at a cost that is not prohibitive.

Farmers who have increased either their scale of output or their productivity in the recent past are likely to be better decision makers or to be more receptive to innovations than farmers with no such recorded changes. Similarly, farmers who have increased the proportion of their production sold are less likely to be self-sufficient—and more likely to register additional increases in dependence on the market—than farmers who do not exhibit a steadily growing involvement in market-oriented production.

Unfortunately, reliable data on total farm production are unavailable in most underdeveloped countries, partly because it is impossible to derive reasonably accurate estimates of production on the basis of amounts marketed when a large and unknown proportion of production is consumed at or near the farm. There have been relatively few consumption surveys in underdeveloped areas and many of those that have been attempted were for urban areas or for too short a period to determine seasonal variations.¹⁰ Attempts to estimate production from areas planted are frustrated by a number of factors, particularly by the difficulty of measuring areas cultivated when fields are irregular—as they are in most of the tropics—and by the shortage of funds for collecting statistics of this sort. It will probably be some years before many of the underdeveloped countries can afford the quantity of reasonably trustworthy agricultural production data needed to identify accurately farmers who are not increasing total agricultural production over the course of time. However, qualitative data on such changes, or lack of them, provided by extension agents and others in the field may help in formulating policy. And it may be possible now to develop reliable quantitative data on yields at a relatively low cost. Yield data can be collected much more quickly than acreage data by sampling; therefore a budget for collecting crop statistics can be stretched much farther if yields alone are measured.

A good many data are already available on trends in the volume of certain cash crops sold. There is little information on quantities sold to domestic consumers, but data are often available on crops sold to large local processors or exported. In many Latin-American and some African countries, use of existing police or fiscal roadblocks for collecting data on quantities of agricultural commodities moving internally would go a long way toward filling gaps in data needed to develop time series on the volume of commodities marketed, area by area. Carefully done farmer surveys might also yield data good enough to determine trends.

¹⁰ See Kaneda and Johnston [16, pp. 230–235] for discussion of consumption surveys of this type in tropical Africa.

Thus, even though data on changes in area cultivated may not be available and are costly to develop, it may be possible in many countries to get a fairly good estimate both of areas where agricultural productivity is increasing (through yield series) and of areas in which farmer commitment to market-oriented production is growing, whether or not this is associated with increments in productivity.

Weak commitment to agriculture

Small-scale producers who are weakly committed to agriculture—those who can easily rely on nonagricultural pursuits—are under less pressure to consider seriously output- or productivity-increasing measures than are those who have no alternative but agriculture; but, depending on their nonagricultural opportunities, they may have more capital with which to innovate or try innovations. The ease with which farmers can turn to wage labor or commerce varies greatly in underdeveloped countries, and, in addition, opportunities in crafts, hunting, fishing, and gathering (for example, wild fruit, honey, wax) can be vastly different. In much of the Amazon and Congo basins, game, fish, and/or insects are still the major sources of protein or important sources of cash income.¹¹ In these areas and others, some farmers can readily find employment seasonally,¹² or for two or three years, elsewhere in small-scale agriculture itself, in large-scale agriculture, in mines or factories, or outside agriculture; yet others have little or no wage-earning opportunity.

In Western Nigeria, Ghana, and parts of the Ivory Coast, and in the cocoa zone of Brazil, where I have done field work on market structure, many farmers report that commerce is closed to them, either because they lack capital or because collusion among professional traders blocks market entry; but in Zambia and the Katanga area of the Congo (Kinshasa), farmers do not report attempts to exclude them from market places.

The nature of off-farm activities can be of considerable importance in changing farmers' decision-making horizons. Farmers who work elsewhere in agriculture—especially those working on farms much like their own except that a higher level of productivity has been achieved—are more likely to adopt innovations than are those whose wage experience is in

¹¹ For the Congo Basin, see my recent publication [19, pp. 12–13 and 19–20].

¹² The consequences of a decision to work as a migrant laborer vary greatly in the Congo Basin, depending on the role of men in the system of cultivation and the number of wives that a farmer has. In some of the 200 or so tribes found there, men may only clear fields; in others, they may also help in one or more other field operations; in still others, they do as much work as their wives. If men only clear land, they can usually get leave from wage labor annually for a week or two to clear the new land that must be opened up every year under shifting cultivation, and agricultural output may be little affected. Each additional wife increases the family allocation of land and its labor force. Therefore, in polygynous households, whatever the negative effect of a husband's absence, it applies to a larger output.

mining or manufacturing. The spread of plows and improved varieties of maize among small-scale African farmers in Rhodesia, Zambia, Kenya, and the Malagasy Republic seems clearly to have been encouraged by the work experiences on farms operated by white settlers [20, pp. 140-141, 157, 163, and 168]. It is not unlikely that migrant laborers elsewhere have also frequently played an important role in disseminating new techniques, new cash crops, or new varieties of those known.

Working for a trader or participating temporarily in commerce where market entry is not blocked may likewise expand the horizons of decision makers in agriculture by introducing them to new inputs (perhaps commercial fertilizers, improved seed, or pesticides) or making them aware of the potential market for commodities which they could grow but have never tried.

P. T. Bauer reports that a Hausa trader contributed considerably to the development of the Nigerian peanut industry by encouraging farmers to try growing peanuts for the export market when the industry was in its infancy [1, p. 76]. My informants report that in the Ivory Coast the number of African egg-producers who inoculate birds for disease, buy mixed feed for them, and otherwise use recommended "modern" production techniques, has grown from zero to about 100 since 1958. In an interview in August 1965, I was told by André Bey, the president of C.O.P.R.A.V.I. (the producer cooperative at Abidjan which accounts for about 80 of the African producers) that only about 10 percent of the Africans investing in this new venture are farmers, and a large proportion are traders. Sidney W. Mintz states that in Haiti one of the characteristics of the trader (usually female) is that she "stimulates improvements in agriculture" [18, p. 285], but he does not give details. D.P. Sinha reports on instances in which traders in central India supplied farmers with potato seed and in return were promised sole right to buy the resulting harvest [29, p. 178].

Commerce may also be an important source of capital for agricultural development. If barriers to market entry are unimportant and there is a fairly long slack season in agriculture, small-scale farmers may be able seasonally to accumulate capital through trading ventures without suffering any reduction of agricultural production.¹³

Insecurity of land tenure

The importance of identifying farmers who have little or no incentive to improve land because of uncertainty about the duration of their rights has long been recognized. However, among farmers with no incentive to improve land there may be important differences in decision making be-

¹³ In at least 4 of the 80-odd tribes in Zambia—the Plateau Tonga, Sala, Soli, and Nsenga—farmers regularly take advantage of opportunities in commerce to buy better tools [20, pp. 303-310].

cause the choice of crop combinations or sequences is restricted by insecurity of land tenure. Small-scale farmers in tropical Africa who obtain land from their own tribe usually have no incentive to improve it because it cannot be sold and because if it is fallowed more than one season it can be reallocated to some other member of the tribe. But such farmers are assured of the right to use land so long as they keep it in cultivation; hence, unlike renters and sharecroppers, they feel no tenure-security restriction on crop combination or sequence decisions. Sharecroppers, too, are of special interest and perhaps should be singled out as a special category because they are sometimes not independent decision makers, being forced to follow the advice of the landlord to secure the use of land.¹⁴

Labor dependency

Small-scale farmers who must manage nonfamily labor can be expected to differ from those with only family labor, both in their decisions on allocation of labor and in their response to innovations. The availability of labor for any particular enterprise or technique (or combination of enterprises or techniques) is much more certain when farmers rely entirely on family labor and usually need to make no decisions with respect to the size of the labor force. Moreover, the cost of family labor is hidden and is incurred whether or not it is utilized. Thus, labor tends to be treated either as though it has no cost or as though it is a fixed cost, until farmers begin to explore the possibility of reaching beyond the family for laborers. Once some paid workers are included in the farmer's labor force, at least part of the total labor force becomes a variable input. The number and kinds of decisions to be made increase as enterprises and techniques that were previously ignored, because they were outside the labor restraint, become eligible, and as the cost and probable return from hired labor are considered in the process of choosing between alternatives.

It is likely that farmers who hire no labor tend to ignore new enterprises or techniques that require more labor than is available within the family, both because of inexperience with hired labor and because of re-

¹⁴ Still another way in which prevailing property rights can affect decision making by small-scale farmers is suggested by Ester Boserup, who points out that greater intensity of land use brought about by switching from single to multiple cropping—a change which she thinks is typical of the process of agricultural development in much of the world—can be retarded in areas with mixed agriculture and communal grazing rights by social pressure put on the innovating individual who starts multiple cropping, the rest of the community being reluctant to reduce the length of the period during which they can use his land as pasture [4, p. 85]. There is great variation in the extent of cattle raising in tropical Africa. In most of the rain forest and in large portions of the humid savanna belts, cattle keeping is precluded by the tse-tse fly. Yet in other areas cattle raising is a major enterprise. And where cattle are kept, the impact of communal grazing is not always as Boserup suggests. Some African tribes fence at least part of their fields, although others never do so [19].

luctance to add another source of uncertainty to their operations. On the other hand, farmers who have already broken away from labor self-sufficiency regard their labor restraint as expandable and have already had some experience with the kind and amount of uncertainty involved when they depend on hired labor; therefore, such farmers are much more likely, other things being equal, to consider innovations.

Capital dependency

Decision making by small-scale farmers can vary because of capital considerations in much the same way as it varies because of labor, and there are reasons to expect variation in decision-making situations among even small-scale farmers if they become dependent on sources outside the family for capital.

Where capital is obtained only through savings, the range of enterprise combinations and techniques considered is severely restricted by the volume of savings. Farmers who can borrow from relatives but cannot, or will not, borrow elsewhere can consider a somewhat wider range of innovations. However, by borrowing they also place themselves in a situation involving more uncertainty, and possibly also a cost-of-capital consideration, through paying either explicit or implicit interest (for example, through an agreement to pay to the lender a share of any net returns resulting from the loan, as is common in much of West Africa, particularly among Moslem groups).

If, however, farmers rely on sources of credit outside the kinship group, the uncertainty added is usually even higher, the obligation to repay is stronger, and the farmer may lose a great deal of his independence as a decision maker. Especially where capital is obtained largely from buyers of crops and where the practice of pledging crops is common (West Africa, for example, and the cocoa zone of Brazil), farmers who obtain credit in the form of advances from crop buyers—or from money lenders through an agreement specifying that particular fields will be devoted to specific crops until the sales from such fields are sufficient to pay the loan and interest, as, for example, in Chile [31] and West Africa—may have their freedom to make decisions regarding crops and techniques severely restricted.

Implications for Research

It is here argued that models which lump all small-scale farmers together as backward are unnecessarily crude. Such analysis makes it easy for policy makers in the less-developed countries to assume that all producers with a relatively low level of productivity at present are also low in *potential* productivity. There are, in fact, important differences in the potential contribution to economic development of different groups of

small-scale farmers within the same country that stem either from their decision-making experience and ability or from the decision-making environment in which they operate. But a large research effort will be required to take advantage of such differences.

There is much more information at present on differences in decision-making experience and decision-making environments than on decision-making behavior—possibly enough so that research based on existent data can lead to considerably more effective policy for small-scale agriculture within the next three or four years.

Besides testing criteria such as those discussed above for classifying decision-making experience and environment, we also need to know what combinations of decision-making situations are typical and what the resulting differences in decision making are. For example, it is reasonable to expect that farmers who exist at a chronically low level of living will not be labor-dependent, but it is even more likely that a chronically low level of living will be found in combination with capital dependency. How common is either combination compared with other possible combinations? How does the decision making of farmers living under one combination of conditions differ from that of farmers living under another combination?

It would seem that a major part of the task is comparative work on how countries differ in the number and distribution of differences in decision-making situations faced by small-scale farmers. In general, one would expect that the more diverse a country's physical and cultural environments, the greater the differences in decision-making situations; but there may be important qualifications or exceptions. Although present data show that in a number of countries there are significant regional variations in decision-making situations among small-scale farmers, we need to know to what extent there are significant variations *within* regions and even in the same community, and how different countries compare in this respect. Whatever the outcome of such research, it can only underscore the inadequacies of the concept of "subsistence agriculture."

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Dynamic Impact Multipliers: A Case Study of White Dry Edible Beans

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A dynamic model for the white dry edible bean sector based upon empirical demand and supply relationships is used (1) to evaluate the impact of governmental support programs, (2) to study the impact which changes in the exogenous variables have on the system, and (3) to estimate the effects which support prices established above free market prices have on production. Unique aspects of this study are (1) the treatment of a group of commodities rather than a single commodity, (2) the explicit consideration given to production and demand interrelationships, and (3) the effects of government programs on both controlled and noncontrolled commodities.

THE purpose of this⁷ article is threefold: first, to simulate the markets for white dry edible beans over the period 1948-1964 under the assumption of absence of governmental intervention; second, to evaluate the impact on the system of changes in the exogenous variables; third, to estimate the effect on the production of these varieties of dry edible beans of the establishment of support prices at levels above free market prices. Toward this end, supply and demand relationships hypothesized to represent the market structure were developed and estimated. Both components could then be kept separate but used together for the purposes stated [5] or they could formally be integrated in a general dynamic model [1, 3, 7, 8, 9, 15].

The White Dry Edible Bean Sector

Supply analysis

The acreage or supply functions are based on the classical equilibrium theory of the firm. This theory provides no way for distinguishing between short-run and long-run response and also delivers no information as to the most relevant price and opportunity costs to be used. With respect to the latter issue, I assumed that expected price and opportunity costs were the most relevant and then used lagged prices as a somewhat naïve price-expectation model. A choice had to be made between using price received per unit of the competing crop or return per acre, thus including yields. A choice could perhaps be made on the following basis, although I recognize that the argument may not be very persuasive to many readers. If yields for a particular variety of beans and competing crops have witnessed a similar development in magnitude, use price per unit. In the opposite case, use returns per acre. Navy beans would fall in the first group, beans grown

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in California in the second. In any event, preliminary results will dictate our choice.

With respect to short-run and long-run response, the Nerlove model [6] was used.

Corn was taken as the competing crop to navy beans.¹ Barley, oats, corn, and sorghum grains were considered the most important competitors to great northerns for acreage.² The relevant farm state prices and/or returns per acre of these feedgrains were aggregated into one series, with weights representing both the importance of the feedgrains per state and the importance of the states in the production of great northerns. Sorghum grains and barley may be considered the most relevant competing crops for small whites and blackeyes.³ Prices and/or returns per acre of these grains were arbitrarily aggregated on a fifty-fifty basis. Besides feedgrains, California beans also compete among each other for land. Consequently, an index of competing bean prices was constructed for every class of California beans here under study. Appropriate weights were used to reflect the regional importance of each variety and its competitors.⁴

When market prices have been at or near support levels in recent periods, there is *a priori* expectation that current support prices will be relevant for planning. This expectation has also been contradicted in the past. Hathaway [4] tested the hypothesis that, after the price support program was inaugurated for navy beans, farmers would respond to the price announced in advance as the price support level. But he found no statistical evidence to substantiate this hypothesis. It is probable that only drastic differences between last year's price and the announced support price would be relevant. In any event, the hypothesis that support prices are relevant in any given year will be tested.

The idea at the outset was to estimate acreage equations. However, data on acreages for small whites, great northerns, and blackeyes covering the observation period could not be found. To avoid the influence of yield fluctuations, supply equations were estimated without the introduction of lagged production, but prices lagged one and two periods were introduced to get at an estimate of the longer-run supply response. Time was introduced in the supply equations for these three classes to capture trends in yields. Account was also taken of the establishment of quotas in some years, primarily by excluding these observations from the analysis [14].

It is assumed that ordinary least-squares estimation of the supply models will yield estimates of the parameters which have minimum variance and are asymptotically unbiased. The results, which are given in Table 1, are

¹ Michigan grows more than 98 percent of the navy bean crop.

² Nebraska (about 40 percent), Idaho (about 25 percent) and Wyoming (about 20 percent) are the principal states where great northerns are grown.

³ Small whites and blackeyes are grown exclusively in California.

⁴ California was for this purpose divided into four regions: Southern region, Coastal region, San Joaquin Valley, and the Sacramento Valley.

Table 1. Estimated supply relations for important varieties of dry edible beans, 1948-1964^a

Variety	Equation	R ²	S	d
Navy beans	$Y_{1t} = -290.0100 + 0.8658 Y_{1t-1} + 197.0946 Z_{1t-1} - 171.5520 Z_{4t-1}$ (0.0903) (45.1428) (46.4770)	0.96	14.78	2.77
Small whites	$Y_{2t} = 2,739.6010 - 725.3139 Z_{4t-1} + 647.6832 Z_{4t-1} + 119.0698 Z_{4t-2}$ (157.0015) (106.1815) (78.3411) $- 406.6399 Z_{6t-1}$ (81.8013)	0.86	49.95	2.31
Great northrens	$Y_{3t} = -11,310.8600 + 2,499.1170 Z_{6t-1} + 2,683.1110 Z_{6t-2}$ (714.9000) (752.4000) $- 3,644.4050 Z_{7t-1} + 1,708.2810 Z_{8t-1} - 66.9035 t$ (1,610.6000) (1,633.3000) (34.4000)	0.90	270.00	1.83
Blackeyes	$Y_{4t} = -674.5211 + 561.5261 Z_{9t-1} + 21.2570 t$ (124.0556) (7.9103)	0.65	126.68	1.28

^a All predetermined variables except Y_{1t-1} and t were in natural logarithms. Standard errors of the regression coefficients are in parentheses. Variables are defined as follows:

Y_{1t} is thousands of acres planted of navy beans in t ,

Y_{2t} is thousands of cwt. produced of small whites in t ,

Y_{3t} is thousands of cwt. produced of great northrens in t ,

Y_{4t} is thousands of cwt. produced of blackeyes in t ,

Z_{1t} is the average price of navy beans in cents per lb. paid to producer in t ,

Z_{2t} is the average price of corn in dollars per bu. paid to Michigan farmer in t ,

Z_{3t} is the average gross income from barley and sorghum in dollars per acre to California producer in t ,

Z_{4t} is the average price of small whites in cents per lb. paid to producer in t ,

Z_{5t} is the average price of beans competing with small whites in cents per lb. paid to producer in t ,

Z_{6t} is the average price of great northrens in cents per lb. paid to producer in t ,

Z_{7t} is the average price of feedgrains in dollars per bu. paid to producers in Idaho, Nebraska, and Wyoming in t ,

Z_{8t} is the average support price in cents per lb. of great northrens paid to producer in t ,

Z_{9t} is the average price of blackeyes in cents per lb. paid to producer in t , and

t is time (1, . . .).

satisfactory. All structural coefficients exhibit signs consistent with economic theory. Statistical evidence for the inclusion of the support price was present only in the case of great northern. Also, there was no statistical support for the inclusion in the supply equation for blackeyes of competing bean prices, feedgrain prices, and own prices lagged two periods. With respect to the most relevant specification of the opportunity cost of feedgrains, returns per acre gave better results for California-grown varieties and price per unit was the better specification for navy beans and great northern. The magnitudes of the long-run and short-run elasticities at the means which can be derived from these results are shown in Table 2.

Table 2. Elasticities of the means derived from estimates of the parameters of supply relationship for some categories of dry edible beans

Elasticities of with respect to	Acreage		Production					
	Navy		Great northern		Small white		Blackeye	
	Short run	Long run	Short run	Long run	Short run	Long run	Short run	Long run
Own price	+0.39	+2.90	+1.21 ^c	+2.52 ^a	+1.03 ^a	+1.22 ^b	+0.74 ^a	
Price of competing beans					-0.65 ^a			
Price of corn	-0.34	-2.53						
Price of feedgrains			-1.77 ^b					
Income from barley and sorghum					-1.16 ^a			

^a One period (one marketing year).

^b Two periods (two marketing years).

Demand analysis

The functions explaining wholesale disappearance⁵ are based on classical economic theory. Consequently, wholesale disappearance is, in general, a function of the own wholesale price, the wholesale price of the closest competitor(s), income, and population. Because it was found that data with respect to CCC acquisitions of great northern were questionable for some years, a typical price equation rather than a demand equation was constructed for this class. Inventory demand has, in general, been made a function of production and government take-over as a corrective factor on production, and of the own price and the price of the closest competitor.

An important characteristic of the price-demand structures of many agricultural commodities is the presence of a support price and, consequently, the existence of the possibility of having to deal with CCC acquisitions. In the cases we know of [2, 4], this characteristic has been taken care of through the construction of a relationship explaining CCC acquisitions. The logic has been the following: CCC acquisitions are a function of the difference between the free market price and the support price. Because

⁵ Wholesale disappearance includes ending stock for navy beans.

the free market price cannot be observed when take-over actually does occur, it is represented by supply, competing supplies, income, and population. Consequently, CCC acquisitions are postulated to be determined by these factors plus the support price. However, this method is correct only when acquisitions by the government occur during every period. Indeed, if we plot in a two-dimensional diagram CCC acquisitions (vertical axis) as a function of the difference between support price and free market price (horizontal axis), then our scatter will exhibit a kink around zero; for, in case of a free market price above the support price, there will be no CCC acquisitions. Consequently, a regression line fitted through all points will automatically be biased, except in the case where the free market price would always have been lower than the support price. In this study, CCC acquisitions are postulated to depend on the variables mentioned earlier as well as on the difference between actual market price and support price. If there are any significant CCC acquisitions, the last variable will nearly equal zero; if there are no acquisitions, this variable should bring the negative take-over resulting from the extension of the true regression line into the third quadrant back to zero.

A dummy variable was introduced in the demand equation for navy beans, with a value of one for the years 1950-51, 1958-59, 1959-60, 1962-63, and 1963-64, and zero for the other years. The justification was the following: In the last four years of those just mentioned, there are unusually high commercial exports of navy beans, the reason for which cannot be found in lower prices or scarcity of other varieties. The *Vegetable Situation* gives as a reason poor bean crops in Europe [10, p. 20; 11, p. 16; 12, p. 14; 13, p. 19]. However, from a survey of FAO data, we find that European bean crops were *not* poor in those years. Given the inadequacy and incompleteness in general of the data for this sector, one suspects that part of these disappearances may have been not truly commercial but rather somehow connected with the price support program.

The years 1952-53 and 1953-54 were deleted from the analysis because of lack of data. Also, some minor adjustments were made [14].

Allowance was made for the possibility that the components of the price-demand structure of navy beans, small whites, and great northernns were determined simultaneously. Furthermore, I allowed for the possibility that navy bean prices influence prices of blackeyes; but since blackeyes are unlikely to have a significant effect on the prices of navy beans, great northernns, and small whites, I assumed that no serious error was committed by not incorporating the price of blackeyes into the price-demand structure of the other varieties. However, for purposes of consistency in further work, the price of navy beans used in the blackeye demand structure was computed from the first round of the two-stage least-squares estimation procedure.

It was assumed that two-stage least-squares estimation of the price-demand structures would result in asymptotically unbiased estimates of the parameters. These results are shown in Table 3.

Dynamics

In order to integrate the estimated supply and price demand components into one general dynamic model, I performed the following operations:

1. I linearized the acreage or supply functions by evaluating the linear terms of a Taylor's expansion of the various equations at the mean values of the appropriate variables.⁶

2. I changed the acreages obtained from the acreage functions to production, using mean yields, and expressed all supply functions as pounds per capita, using mean population.⁷

3. I computed the reduced forms of the price-demand market component from the two-stage least-squares results. In order that I might deal with a structure from which governmental intervention was absent, I did not use in the computation the equations explaining CCC acquisitions. Also, I dropped the dummy variable in the demand equation for navy beans.⁸

4. I redefined variables where higher-order lags were involved.⁹

5. In the dynamics model, I used a single designation for a given variable

⁶ A structural system with one-period lags involved (and higher-order lags can always be reduced to one-period lags) can after linearization be expressed in matrix notation as follows:

$$-\beta Y_{(t)} = \nu Y_{(t-1)} + \Gamma X_{(t)} + AE_{Y(t)} + BE_{Y(t-1)} + CE_{X(t)}.$$

The vectors of variables $Y_{(t)}$, $Y_{(t-1)}$, and $X_{(t)}$, as well as the matrices of coefficients ν , Γ , β , are familiar to the readers. If relationships in the system involved $Y_{(t)}$, $Y_{(t-1)}$, or $X_{(t)}$ in a natural logarithmic form, and if subsequent linearization took place, involving only the linear terms in a Taylor's series expansion, then for every t and every variable involved, we could sum the neglected terms in the expansion. This sum is of the form

$$\alpha \sum_{n=1}^{\infty} \{ [-1^n] [n!/(n+1)!] [(x_t - \bar{x})/\bar{x}]^{n+1} \},$$

where \bar{x} represents the value of the point at which linearization took place. The factor following α is always negative for suitable chosen \bar{x} where α itself is the estimate of the parameter on $\log_e x_{(t)}$. Therefore, these vectors $E_{Y(t)}$, $E_{Y(t-1)}$, and $E_{X(t)}$ are vectors of linearization errors and A , B , and C are matrices of the appropriate coefficients. Given this idea, there are several possible ways of determining the size of the error introduced by linearization.

⁷ Y_{1t} through Y_{4t} (Y_{1t-1} through Y_{4t-1}) are therefore now in pounds per capita. The variable Z_{5t} was composed of the prices of blackeyes, large lima beans, and pink beans, with appropriate weight factors. For present purposes, this variable was split up into its components. The support price of great northern was the only one found to be of any relevance in the supply equations. When this price was set equal to zero, an unrealistically low supply resulted. It was therefore assumed that, with respect to the estimated supply equation for great northern, the support price was excluded by setting this price equal to the average of the last eight years, when it was considerably below the free market price.

⁸ Identities involving the equalization of demand and supply were added to the structure to compute the reduced forms.

⁹ For example, $Y_{8t-2} = E^{-1} Y_{8t-1} = Y_{14t-2}$.

Table 3. Estimated demand and price relationships for important varieties of dry edible beans, 1948-1964^a

Variety	Equation	R ²	S	d
Demand for navy beans	$Y_{6t} = 3.62477 - 0.28322Y_{9t} + 0.08269(Y_{9t} + Y_{10t})^b - 0.90644X_{1t} + 0.78091X_{4t}$ (0.09190) (0.05373) (0.41081) (0.41087)	0.92	0.18437	2.81
Demand for small whites	$Y_{6t} = 0.32261 + 0.08889Y_{9t} - 0.08568Y_{10t} + 0.30965X_{1t}$ (0.01876) (0.01677) (0.09968)	.74	.04852	2.02
Ending stocks of small whites	$Y_{7t} = 0.00880 - 0.02011Y_{9t} + 0.00892Y_{10t} - 0.10254Y_{12t} + 0.25011X_{4t}$ (0.00834) (0.00979) (0.09299) (0.09663)	.71	.01542	2.59
Price of great northern	$Y_{8t} = 3.09932 + 0.48622Y_{9t} + 1.73402X_{1t} - 0.07555X_{3t}$ (0.22027) (2.0561) (0.58355)	.39	.72001	2.48
Demand for blackeyes	$Y_{12t} = 0.61857 + 0.01659\hat{Y}_{9t} - 0.021843Y_{11t} - 0.15951X_{1t}$ (0.01169) (0.00497) (0.07372)	.74	.04014	2.32
Ending stocks of blackeyes	$Y_{12t} = -0.04649 - 0.00224\hat{Y}_{9t} - 0.00743Y_{11t} + 0.36962X_{5t}$ (0.00481) (0.00734) (0.11436)	.76	.02420	2.12
CCC purchases of navy beans	$Y_{14t} = -1.58754 - 0.01929(Y_{9t} + Y_{10t}) + 0.01105Y_{12t} + 0.55279X_{1t}$ (0.05564) (0.18235) (0.46998) + 0.59240X _{2t} - 0.81436X _{3t} + 0.03091X _{7t} (0.18010) (0.18236) (0.15200)	.92	.19310	3.02
CCC purchases of small whites	$Y_{15t} = -0.62231 - 0.05285Y_{9t} + 0.03245Y_{17t} - 0.11106X_{1t} + 0.55341X_{4t}$ (0.01818) (0.01909) (0.06045) (0.18029) + 0.11209X _{3t} (0.02629)	0.86	0.02544	2.27

^a X_{1t} is in natural logarithms. Standard errors of the regression coefficients are in parentheses. The variables are defined as follows:
(Balance of footnotes on following page)

even though it was denoted by different symbols in the supply and demand equations.¹⁰

The whole set of equations can now easily be brought into the following framework:

$$(1) \quad Y_t = \Pi_1(Y_{t-1}) + \Pi_2 Z_t,$$

where Y_t , Y_{t-1} , and Z_t are vectors of endogenous, lagged endogenous, and exogenous variables, and Π_1 and Π_2 are appropriate matrices of coefficients. If it can be assumed that the exogenous variables are linear functions of time and if each of the roots of Π_1 has a modulus smaller than unity, then the time path of the endogenous variables can be written [10] as

$$(2) \quad Y_t = (I - \Pi_1)^{-1} \Pi_2 (B_0 + B_1 t) - (I - \Pi_1)^{-2} \Pi_1 \Pi_2 B_1,$$

where

$$(3) \quad Z_t = B_0 + B_1 t.$$

It should be noted that expression (2) incorporates the idea of a sufficient lapse of time since the starting point of the system so that $[\Pi_1]^n$ approximates the zero matrix, where n is the number of periods elapsed.

On the assumption that Π_1 is stable, the long-run stationary values of the

¹⁰ For example, the price of navy beans in the supply equations was indicated by Z_{1t} and in the demand equations by Y_{9t} . For computation of the general dynamic model (expression 1), Z_{1t-1} was replaced by Y_{9t-1} in the supply equations.

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- Y_{8t} is total demand in lbs. per capita of navy beans in t ,
 Y_{9t} is production and beginning stocks minus ending stocks of small whites t , in lbs. per capita,
 Y_{7t} is commercial ending stocks of small whites in lbs. per capita in t ,
 Y_{3t} is average price in cents per lb. of great northern in t ,
 Y_{2t} is average price in cents per lb. of navy beans in t ,
 Y_{10t} is average price in cents per lb. of small whites in t ,
 Y_{11t} is average price in cents per lb. of blackeyes in t ,
 Y_{12t} is commercial ending stocks of blackeyes in lbs. per capita in t ,
 Y_{13t} is production per capita and beginning stocks per capita minus ending stocks per capita of blackeyes in t (in lbs.),
 Y_{14t} is CCC acquisitions of navy beans in t in lbs. per capita,
 Y_{15t} is CCC acquisitions of small whites in t in lbs. per capita,
 Y_{16t} is difference between actual market price and support price of navy beans in t in cents per lb.,
 Y_{17t} is the difference between actual market price and support price of small whites in t in cents per lb.,
 Y_{8t} is average price in cents per lb. of navy beans in t , computed as a function of the exogenous variables in the model,
 X_{1t} is disposable income in thousands of dollars per capita in t ,
 X_{2t} is production in lbs. per capita of navy beans in t ,
 X_{3t} is production in lbs. per capita of great northern in t ,
 X_{4t} is production plus beginning stocks in lbs. per capita of small whites in t ,
 X_{5t} is production plus beginning stocks in lbs. per capita of blackeyes in t ,
 X_{6t} is a dummy variable (see page 315),
 X_{7t} is the support price of navy beans in t , in cents per lb., and
 X_{8t} is the support price of small whites in t , in cents per lb.

^b In preliminary work, coefficients of the variables Y_{3t} and Y_{10t} were nearly identical; the variables were consequently added together to save on degrees of freedom.

endogenous variables corresponding to a given set of exogenous variables are given by

$$(4) \quad Y = (I - \Pi_1)^{-1} \Pi_2 Z.$$

Therefore, if the vector of exogenous variables changes from B_0 to $B_0 + B_1$, and if that change is permanent, the equilibrium change in the vector of endogenous variables is given by

$$(5) \quad \Delta Y = (I - \Pi_1)^{-1} \Pi_2 B_1.$$

This equilibrium change, however, might fully materialize only after several periods. To evaluate the change per period, we may write, after consecutive substitutions into expression (1),

$$(6) \quad Y_t = \Pi_1^t y_0 + \Pi_2(B_0 + B_1) + \Pi_1 \Pi_2 B_0 + \Pi_1^2 \Pi_2 B_0 + \cdots + \Pi_1^{t-1} \Pi_2 B_0$$

and

$$(7) \quad Y_{t-1} = \Pi_1^{t-1} y_0 + \Pi_2 B_0 + \Pi_1 \Pi_2 B_0 + \Pi_1^2 \Pi_2 B_0 + \cdots + \Pi_1^{t-2} \Pi_2 B_0.$$

For a stable Π_1 , the matrices Π_1^t and Π_1^{t-1} approximate zero (for sufficiently large t), and therefore

$$(8) \quad Y_t - Y_{t-1} = \Pi_2 B_1.$$

Then

$$(9) \quad Y_{t+1} - Y_t = \Pi_1(Y_t - Y_{t-1}) = \Pi_1 \Pi_2 B_1;$$

and in general

$$(10) \quad Y_{t+n} - Y_{t+(n-1)} = \Pi_1^n \Pi_2 B_1.$$

Under the assumption of a stable Π_1 matrix, the change will eventually equal zero or the endogenous variables will have obtained their new equilibrium position. Of great importance, of course, is the speed of adjustment. An analysis of the time path of the change would involve an investigation of $\Pi_1^n \Pi_2 B_1$ for $n = 0, 1, 2, \dots$

The Π_1 and Π_2 matrices are reported in Tables 4 and 5. In order to evaluate expression (2), we need to estimate the trends along which the values taken by the exogenous variables developed through the course of time.¹¹ They were obtained by simple regression analyses over the period 1948–1964. In each analysis, one exogenous variable was treated as a dependent variable and time as an independent variable. The results are given in Table 6.

The stability of the Π_1 matrix was checked through consecutive multiplication by itself. The largest element of $(\Pi_1)^1$ was of the order of 10^1 ; the largest element of $(\Pi_1)^{10}$ was of the order of 10^{-1} . Thus, Π_1 is a stable matrix.

¹¹ This procedure may to many sound much too naïve. I will, however, present also results derived from the system when this assumption is not used.

Table 6. Estimated relationships between exogenous variables and the time trend

Dependent variable	Constant term	Trend coefficient	R^2	Standard error of estimate
Price of corn _{t-1} (Michigan)	1.77775	-0.05091	0.58	0.21000
Income from barley and sorghum _{t-1} (California)	40.81649	+0.67188	0.29	5.38000
Price of feedgrains _{t-1} (Idaho, Nebraska, Wyoming)	1.26425	-0.02352	0.61	0.09304
Income	1.25245	+0.05799	0.99	0.02376
Price of large limas _{t-1}	14.81225	-0.20872	0.08	3.65655
Price of pink beans _{t-1}	9.48525	-0.02958	0.00	2.11184

The Results

Table 7 compares the results obtained from evaluating expression (2) with the actual outcomes for the period 1948-49 through 1963-64.¹²

Before drawing any conclusions from this comparison, we should remind ourselves of the framework of the comparison and of the assumptions and simplifications accepted to arrive at the results from application of expression (2).

First of all, the actual data on supplies and prices are records of the sector in operation under the existence of a price support program, whereas the results from applying expression (2) have been established under the assumption of no governmental interference whatsoever. Moreover, one has to remember that expression (2) in no way gives an answer to the question as to what happens in the years immediately following a change from the existence of a price support program to the absence of such a program.

Secondly, part of the estimated structural system was linear and part has been linearized. Other simplifications were introduced through the use of mean yields and the mean of the U.S. population over the observation period, and the exclusion of shocks such as the Korean War disturbance.

Against the results obtained from the evaluation of expression (2), we can put another set (2'), derived from consecutive use of the actual estimated supply and price-demand structure (without linearization) and using actual yields, actual population, and the actual level of exogenous variables as registered for every year. The two sets are not fully comparable, however, especially for the first part of the period. First, the actual prices of the year 1947-48 were taken as initial conditions to compute set (2'). Second, the

¹² The reader can for the moment ignore columns under (2').

Table 7. Supplies per capita of dry edible beans: actual outcomes, and estimates based on the models of this study, 1948-1964^a

Year	Navy beans ^b			Small whites			Great northens			Blackeyes		
	Actual	Estimated		Actual	Estimated		Actual	Estimated		Actual	Estimated	
		(2)	(2')		(2)	(2')		(2)	(2')		(2)	(2')
1948-49	3.112	2.235	3.102	0.512	0.407	0.505	2.894	1.035	2.593	0.750	0.454	0.667
1949-50	3.563	2.279	2.370	0.419	0.399	0.456	2.140	1.063	1.151	0.377	0.466	0.376
1950-51	3.441	2.323	1.704	0.322	0.390	0.291	1.183	1.071	0.303	0.428	0.488	0.551
1951-52	3.105	2.366	3.542	0.552	0.382	0.946	1.151	1.079	1.676	0.627	0.471	0.595
1952-53	—	2.410	2.282	—	0.374	0.437	—	1.087	0.890	—	0.473	0.403
1953-54	—	2.454	1.801	—	0.365	0.306	—	1.095	0.464	—	0.475	0.545
1954-55	2.013	2.498	1.205	0.456	0.356	0.542	1.244	1.102	1.198	0.519	0.477	0.535
1955-56	2.707	2.542	2.263	0.536	0.348	0.568	1.218	1.110	1.800	0.621	0.479	0.571
1956-57	3.068	2.586	2.583	0.499	0.339	0.456	1.103	1.118	1.429	0.541	0.484	0.491
1957-58	2.100	2.630	1.574	0.481	0.331	0.332	0.901	1.126	1.012	0.546	0.484	0.498
1958-59	2.900	2.674	2.633	0.467	0.322	0.596	1.193	1.134	1.173	0.578	0.486	0.566
1959-60	3.420	2.718	2.736	0.569	0.314	0.318	1.320	1.142	0.730	0.566	0.489	0.446
1960-61	3.627	2.762	2.563	0.425	0.306	0.428	0.923	1.150	0.602	0.408	0.491	0.502
1961-62	3.875	2.805	2.836	0.264	0.297	0.201	0.950	1.158	0.565	0.544	0.493	0.485
1962-63	3.646	2.849	2.524	0.346	0.289	0.349	0.814	1.166	0.635	0.400	0.495	0.481
1963-64	4.172	2.893	2.877	0.331	0.280	0.333	1.218	1.174	0.674	0.461	0.498	0.448

^a The estimates for both (2) and (2') were made under the assumption that there were no governmental price supports in the white bean and blackeye bean sectors. Results under (2) were obtained from the integrated dynamic model. Results under (2') were obtained from the consecutive use of the separate supply and demand relationships, with 1947-48 serving as the starting point.

^b Supplies per capita for navy beans (actual) include CCC domestic sales. These were not very significant except in 1950-51.

Korean War disturbance was allowed to exert its influence. Third, a complete structure was developed for lima beans. The only link with the model for white varieties was established through the supply equation for small whites. The lima bean model was so unstable that I imposed actual support prices as lower bounds on the prices for lima beans. In other words, the prices of large lima beans used to compute set (2') were not very different from those used to compute set (2), and consequently we should not expect the influence on the production of small whites to be very different.

Focusing on the more recent part of the observation period, we find the results from (2) and (2') not very different, except for supplies in the case of great northern and prices in the case of small whites. I may further point out that considerable CCC acquisitions of navy beans and great northern did occur in the years in which great discrepancies between observed values and evaluations of expression (2) occurred as shown in Table 7. For example, CCC acquisitions of navy beans in the period 1960-1964 amounted to nearly 7 million hundredweight or 25 percent of production. Navy beans and, to a lesser extent, great northern are also the varieties for which prices as computed in (2) or (2') are distinctly below support prices (Table 8).

It is of value to know the impact of a one-unit permanent change in the price of corn, in the income from feedgrains, and in disposable income on the quantities supplied (quantities demanded) and on the prices of the varieties of beans here considered, in the absence of governmental intervention. This concept has been defined in the literature as a multiplier. This concept of multiplier has to be clearly distinguished from multipliers referring to one-shot or impulse exogenous changes. To obtain these effects, we have to evaluate $(I - \Pi_1)^{-1}\Pi_2$. The results have been summarized in Table 9.

Again, on the basis of this table, the reader can draw several conclusions. He may ask, for example, what effect an increase in the prices of corn and other feedgrains would have on the supply and price of navy beans. Suppose that the price of corn in Michigan rises by \$1.00 per bushel, that the average price of feedgrains in the regions producing great northern rises by \$0.80 per bushel, and that average gross income from sorghum and barley rises by \$57.20 per acre in California, all other things remaining constant. As a result, price per hundredweight of navy beans would rise by \$4.65 and supplies would decrease by $[0.870 (1.00) - 0.005 (57.20) - 0.011 (0.80)]$ or by 0.575 lbs. per capita. The effect of the same change in feedgrain prices on small whites would be to increase the price by \$7.15 per hundredweight and decrease the supply by 0.193 lbs. per capita.

Up until now, we have not discussed specifically the potential impact of the price support program on the supply of dry edible beans. Indirectly, we have seen some results by comparing actual supplies and supplies generated by evaluation of expression (2). To have a more complete picture, we

Table 8. Prices of dry edible beans: actual outcomes, and estimates based on the models of this study, 1948-1964^a

Year	Navy beans			Small whites			Great northern			Blackeyes		
	Actual	Estimated		Actual	Estimated		Actual	Estimated		Actual	Estimated	
		(2)	(2')		(2)	(2')		(2)	(2')		(2)	(2')
1948-49	8.10	9.07	3.50	8.83	9.48	3.23	7.76	7.77	5.01	6.29	12.01	5.64
1949-50	7.16	8.84	7.92	7.49	9.34	8.01	6.72	7.65	7.41	12.46	11.71	13.42
1950-51	7.53	8.60	17.93	10.39	9.20	18.42	7.35	7.54	12.07	14.39	11.40	13.76
1951-52	7.83	8.36	3.00	8.12	9.07	3.00	7.93	7.44	5.15	9.30	11.10	5.96
1952-53	—	8.12	8.17	—	8.93	8.98	—	7.33	7.80	—	10.79	12.41
1953-54	—	7.89	11.69	—	8.80	13.39	—	7.22	9.53	—	10.49	11.08
1964-65	10.34	7.66	13.93	11.18	8.66	13.30	8.37	7.11	10.66	11.36	10.18	11.69
1955-56	7.34	7.41	7.40	8.24	8.52	7.38	6.79	6.99	7.51	6.51	9.88	7.89
1956-57	7.39	7.18	5.99	8.08	8.39	7.32	6.77	6.88	6.90	8.02	9.58	8.76
1957-58	9.18	6.93	12.50	9.64	8.23	14.48	9.44	6.77	10.15	7.72	9.27	11.88
1958-59	7.31	6.70	4.86	9.18	8.12	5.21	7.49	6.66	6.49	7.33	8.97	6.24
1959-60	6.29	6.46	5.55	7.47	7.98	8.63	7.13	6.55	6.13	7.28	8.66	9.05
1960-61	6.53	6.22	5.82	9.08	7.84	8.04	7.68	6.44	7.15	10.86	8.36	7.68
1961-62	6.85	5.98	5.37	10.36	7.71	9.85	7.16	6.33	6.92	7.15	8.05	7.79
1962-63	6.90	5.75	6.42	9.45	7.57	9.48	8.90	6.22	7.48	8.75	7.75	8.21
1963-64	6.85	5.51	4.32	9.44	7.44	7.89	7.43	6.11	6.51	10.67	7.44	7.72

^a See footnote a to Table 7.

Table 9. Impact of a one-unit permanent positive change in selected exogenous variables on the quantities supplied (demanded) of some varieties of dry edible beans^a

	X_1	Z_{2t-1}	Z_{3t-1}	Z_{7t-1}
	<i>1,000 per capita</i>	<i>dollars per bushel</i>	<i>dollars per acre</i>	<i>dollars per bushel</i>
Quantity supplied (demanded) of navy beans in lbs. per capita	-0.286	-0.870	+0.005	+0.011
Quantity supplied (demanded) of small whites in lbs. per capita	+0.055	+0.143	-0.006	+0.003
Quantity supplied (demanded) of great northern in lbs. per capita	+0.316	+0.827	+0.000	-2.043
Quantity supplied (demanded) of blackeyes in lbs. per capita	-0.057	+0.047	+0.000	+0.000
Price of navy beans in dollars per cwt.	-0.23	+4.65	+0.00	+0.00
Price of small whites in dollars per cwt.	+1.15	+3.15	+0.07	+0.00
Price of great northern in dollars per cwt.	+0.84	+2.19	+0.00	+0.15
Price of blackeyes in dollars per cwt.	-1.66	+1.36	+0.00	+0.00

^a It is, of course, in reality impossible to change any of the variables Z_{2t-1} , Z_{3t-1} , or Z_{7t-1} without changing them all.

go back to the original linearized supply functions. The framework is the following: Suppose the support prices have been at or below free market prices. Assume now that the prices are raised by \$1.00 per hundredweight \$0.01 per pound above their equilibrium at a given point in time. The question then is, What is the effect on production, assuming that the increase is kept for as many periods as necessary for full realization of the impact, other factors being constant?

We have to evaluate $(I - \Pi_1)^{-1} \Pi_2 B_1$ per equation in terms of the coefficients of that particular equation. For example, the linearized acreage function for navy beans is

$$Y_{1t} = 50.8205 + 0.8658 Y_{1t-1} + 24.1242 Z_{1t-1} - 129.9634 Z_{2t-1}.$$

Therefore, the total impact of a permanent support price \$1.00 per hundred-weight above the free market price is

$$[1 - 0.8658]^{-1} [50.8205 \quad 24.1242 \quad -129.9634] \begin{pmatrix} 0 \\ 1 \\ 0 \end{pmatrix} = 179,760 \text{ acres.}$$

If one is interested in the path of adjustment, one computes, of course, $(0.8658)^n (24.1242)$, where $n = 1, 2, 3, \dots, \infty$. The consecutive values in the case of navy beans are (in thousands of acres): 20.88, 18.10, 15.67,

13.55, etc. For those supply functions not including the lagged dependent variable, the expression to be evaluated is reduced to $\Pi_2 B_1$ per equation in terms of the coefficients of that particular equation. The results are summarized in Table 10.

Table 10. Final impact on production of a permanent increase in the support price of \$1.00 above the free market price

Variety	Units	Percentage of mean (1948-1964)
Navy beans	179.76 (thousands of acres)	36.0
Small whites	42.36 (thousands of cwt.)	6.5
Great northern	869.70 (thousands of cwt.)	48.0
Blackeyes	57.42 (thousands of cwt.)	7.5

The results with respect to navy beans and great northern beans reflect the improvement in the competitive position of these beans versus feedgrains. The response of small whites and blackeyes to the indicated changes is more limited, partly because, at least in the case of small whites, support prices of competing beans were also put at \$1.00 above the free market price.

As exemplified by the per-period breakdown of the total increase for navy beans, it is dangerous to estimate the influence of a support price program on the basis of a short-run response model. On the basis of such a model, Hathaway concluded that supply expansion of navy beans in response to higher support prices would be quite limited [4].

Conclusion

A dynamic model, such as has here been applied to a particular sector, can lead to many more insights into the basic character of an economic system than a static model. Furthermore, we are also apt to get results which are more nearly correct. Because a dynamic model is more complex than its counterpart, it is natural that further simplifications are introduced in an effort to come to practical results. Research is needed as to the impact of these simplifications on the results obtained.

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PROCEEDINGS PAPERS

WINTER MEETING OF THE AMERICAN FARM ECONOMIC ASSOCIATION WITH ALLIED SOCIAL SCIENCE ASSOCIATIONS

Washington, D.C., December 28-30, 1967

AGGREGATE DEMAND SHIFTS, LABOR TRANSFERS, AND INCOME DISTRIBUTION

CHAIRMAN: VERNON W. RUTTAN, UNIVERSITY OF MINNESOTA

Effects of Shifts of Aggregate Demand upon Income Distribution*

HYMAN P. MINSKY

IN THE United States a large portion of those living in poverty and an even larger portion of those living close to poverty do so because of the meager income they receive from work. The questions that need answering if, some day, a serious war on poverty is to be mounted relate to the distribution of income and the available policy tools which can affect the distribution of income in the relatively short run. The emphasis upon the short run makes programs based upon accelerated investment in humans irrelevant. It also means that the impact of economic growth upon the extent of poverty [1] is not germane. The policy problem is to affect the distribution of income, given the capacity to produce and the skills and locations embodied in the labor force.

Early in the preparations for a possible war on poverty, I was drawn into discussions dealing with the prospective campaign. My view was summarized in the subtitle of a talk at the Berkeley conference [6], a subtitle that was too flip for the editor of the published version. The subtitle was "Is This Trip Necessary?" I consciously ignored the poverty of those not expected to be in the labor force, which can be handled only by a sufficiently generous scheme of transfer payments. The argument of the paper, and of some subsequent writings, was that the achievement and

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sustaining of tight full employment could do almost all of the job of eliminating poverty.

My thesis was that tight full employment would help eliminate poverty in at least two ways: (1) by employing the unemployed and moving part-time workers to the fully employed class, and (2) by fostering labor market conditions such that low wages will increase at a faster rate than high wages.

Tight full employment as I defined it was neither achieved nor sustained during the 1960's. As an interim measure of tight full employment, I suggested a measured unemployment rate of 3.0 percent, considerably below the best we have achieved since 1953 but well above measured rates in Europe. In spite of a war added onto an investment boom, the lowest monthly unemployment rate achieved during the current expansion was 3.5 percent, and we never got far below 3.7 percent for a sustained period.

The events of the expansion indicate that we cannot rely upon "undirected" aggregate demand increases to do the job which I claimed it could do. This is because of two facets of what happened:

1. The crunch of August-September 1966 showed that a sustained expansion, or even sustained growth, breeds "stresses and strains" within the economy which make the continuation of the expansion or growth unlikely. Thus, sustaining tight full employment may require more than just an expansionary monetary and fiscal policy.

2. The distribution of relative wages did not appreciably improve during the expansion of the 1960's.

Thus, it may be that greater attention to the structure of aggregate demand is necessary if a desired change in relative wages is to be achieved. The question is whether "directed" demand can achieve the goal of greater equality or whether a system of direct controls is needed, with or without directed demand.

Income Distribution as a Policy Goal

After the summer of 1967, the "question" of the distribution of income, in all its dimensions and not only as measured money income, should be the leading domestic issue. One way of stating the problem is that there is some maximum inequality to the distribution of a generalized income that is compatible with social stability. It seems clear that a good wording of the leading social imperative is "to assure domestic peace and tranquility."

The maximum inequality consistent with any set of social goals is not invariant. It is useful to conjecture, following Scitovsky [11], that in a technically sophisticated, highly urbanized society inequality of measured

income more truly reflects inequality of real or "subjective" income than in a less sophisticated, rural environment. In the dimensions not measured by the earning and spending of private income, life may be easier and the contributions of public and free goods more evenly distributed in a rural and small town setting than in our modern cities. Whereas the "inequality" in the distribution of private income may be partially offset by the distribution of free and public goods in some settings, in our modern urban ghettos the coverage of free goods has decreased and public goods typically are distributed so as to aggravate the measured inequality of income. In addition, there are problems of perception and tradition: rural poverty may be associated with a belief in the inevitability of status differences, whereas urban societies are associated with a belief in social and economic mobility.

Another reason why a consensus that equity exists is required is that, in a modern urban society, for a broad set of occupations, public benefits exceed private benefits. The dependence of any particular unit's output upon the smooth working of other units is so obvious that observed difference in income received must correspond to some notion of "fairness."

Roughly speaking, there are two classes of policy instruments which can be used to affect income distribution: one set affects factor payments from production; the other affects disposable income by a system of transfer payments.

There has been much discussion of broadening the tax system to provide transfer payments by right, the so-called negative income tax [3]. Objections to the negative income tax are possible on two planes. One is that if the income guarantee is "adequate" a sizable disincentive effect may exist, therefore decreasing attainable real gross national product. The second set of objections is political and social: the creation of a large class of social remittance men and women is not conducive to either social cohesion or domestic tranquility.

The virtues of the negative income tax are that it eliminates the stigma and costs of case-load welfare and that in principle it could provide adequate incomes for the economically inactive portion of the population. More nearly adequate welfare and pension schemes and, in addition, some way of guaranteeing such income protection as a right are necessary. But it is an admission of an inability to make the production process respond to social goals to resort to taxation transfers as a substitute for income from factor payments.

On the other hand, the position hypothesized by Henry Simons [12, 13] that an enterprise economy tends to generate a distribution of income and wealth that is inconsistent with the continuation of political democracy seems particularly timely. The solution to this dilemma proposed by Si-

mons, an effective system of progressive income taxation and transfers, is as relevant for our time as it was for his.

The "Crunch" and the Limitation to Aggregate Demand

The 1960's witnessed the apparent victory of Keynesian policy. However, the successful application of Keynesian policy may result in an economy that is inherently unstable. This instability is not the result of a tendency to stagnate or enter into a deep depression state; rather, it is due to a tendency to explode.

Between the end of World War II and the crunch of 1966, the American economy operated within an expectational climate in which decision makers were increasingly expecting reasonably full employment to be maintained and to an increasing extent both households and business were expecting next year to be better than this year. This trend in the expectational climate resulted in an explosively increasing demand for private investment in the mid 1960's.

Rising investment generates savings. During the 1950's, when a nascent investment boom took place, the savings took place as a result of changes in the federal government's budgetary position. This was due to the application of conventional fiscal precepts in designing tax and spending programs. In the 1960's, as a result of the combination of "modern" fiscal policy ideas and an accidental war, government revenues did not rise rapidly relative to government spending when private investment "exploded." Thus, the savings to offset the explosion of private investment had to come from the private sector.

The "Kaldorian" relation [4], in which the propensity to save out of profits is greater than the propensity to save out of household disposable income, means that income distribution shifts towards profits whenever savings must be generated in the private sector. One way in which this change in the distribution of income can take place is through inflation. A rise of prices in excess of the rise in money wages lowers real wages. This classical inflation pattern, in which savings are forced by rising prices, was evident during 1966 and is an element in the continuing price pressure of 1967. Thus, not only does the "classical" (wages and profits) distribution of income "deteriorate" during an investment boom but also the deterioration is associated with a politically unpalatable inflation.

The contention that a measured 4-percent unemployment rate is full employment apparently was borne out by the accelerated rise in prices during 1966 and 1967. However, as wage increases were modest throughout most of 1966, the guidelines broke more on the price than the wage front; the mechanism of the inflation was not that of the Phillips curve [8].

Private investment lagged in the first three years of the current expansion and virtually exploded in the second three years. This investment explosion put serious pressures upon financial markets even in the absence of Federal Reserve action. When the Federal Reserve System applied some constraint, a "mini-panic" occurred.

The "mini-panic" of 1966 can be interpreted as evidence that sustained full employment may result in such an explosive increase in investment demand that it becomes impossible to achieve the sustained growth in demand necessary for continuing full employment. This is so because the investment boom is due to an "euphoric" expectational climate, and to break the investment boom it is necessary to change the expectational climate. Once the expectational climate is changed, all of the private sectors become sluggish. Only by accident would public demand increase sufficiently quickly so that a relatively deep recession would not follow such a change in expectations. Of course the deep depression ratifies the changed expectations and thus it will take time to rebuild confidence.

The destabilizing investment boom of the 1960's took place before unemployment rates were lowered to the levels which I characterized as tight full employment. If such explosive investment booms are a characteristic of American capitalism and they occur prematurely, then, in order to achieve and sustain tight full employment, it is necessary to contain the potential investment boom. One possible way is so to direct demand that it does not generate a large inducement to invest. Another possibility is to control investment directly, either by licensing investment or by licensing access to financial markets.

Impact of the Great Expansion upon Income Distribution

An important characteristic of the present-day American economy is the widespread belief, which has been validated by the overall performance of the economy since World War II, that next year will be better than this year. One way in which this "betterness" appears is in higher money incomes. Thus, the convention of annual "improvement" factors in union contracts. As long as a pattern of annual wage increases exists, changes in income distribution among wage earners will be due to the pattern of wage increases.

The evidence presented by Ulman [14], mainly for post-World War II years prior to the recent expansion, is that a significant positive correlation exists between the original level of gross hourly earnings and the percentage change in gross hourly earnings. This contrasts with the finding for the depression and war years [9].

The pattern of arithmetic increases in wages that occurred during World War II translates into geometric increases that are inversely related to the original wage level, thus decreasing the range of relative

earnings. During the early postwar period, the range changed but little. Between 1953 and 1960, the years of increasing overall slack in labor markets, the range widened. Between 1960 and 1966, the range of weekly wages has shown no real change, even though the dispersion of hourly rates as measured by the coefficient of variation has shown some narrowing over this recent expansion.

The initial observation for what follows is 1948. This year may be too close to the end of World War II, with its elaborate wage and price controls, to serve as a "model" for relative wages. Between 1953 and 1961, the trend was toward higher unemployment rates. The expansion of 1961-1966 saw aggregate unemployment rates fall from 6.7 percent to 3.8 percent. Does chronic and growing labor market slack widen the range of weekly earnings among industries, whereas a period of labor market tightening or tightness narrows the spread?

Relative earnings in the 21 two-digit manufacturing industries plus mining, contract construction, wholesale trade, and retail trade were examined. For each year, the average weekly wage in each of the 25 sectors was divided by average earnings in all manufacturing to get relative wages.

In 1948, weekly earnings in four industries (Table 1) were in excess of 120 percent of the average earnings, and three industries exhibited earnings that were less than 80 percent of the base. In sharp contrast, in 1966, weekly earnings in six industries were in excess of 120 percent of all the manufacturing earnings, and earnings in six industries were below 80 percent of the base. Whereas in 1948, of the 25 industries, 18 were in the range "weekly earnings in all manufacturing ± 20 percent," in 1966 only 13 were in this range. (If " ± 10 percent of all the manufacturing earnings" is used as the central group, 12 of the 25 industries were in the range in 1948, whereas only 9 were in 1966.)

Not only has there been a market thinning out of the middle of the range of weekly earnings by industry, but also the minimum average weekly income as a ratio to the average has decreased. In 1948, weekly earnings only in tobacco manufactures were below 70 percent of the average. In 1966, three industries exhibited weekly earnings lower than 70 percent of all manufacturing: these were leather and leather goods, apparel and related manufacturing, and retail trade.

Of the ten industries with the highest weekly earnings in 1948, seven had increased their relative earnings by 1966, one exhibited no serious change, and two (mining, and printing and publishing) had suffered substantial relative declines.

Of the eight industries with the lowest relative wages in 1948, seven had experienced a substantial decline in their relative wages by 1966. The exception, tobacco, had the lowest average weekly earnings in 1948 (69

Table 1. Average weekly earnings as a ratio to average weekly earnings in manufacturing, 1948, 1953, 1960, and 1966

Industry	1948	1953	1960	1966
Mining	1.234	1.178	1.175	1.158
Contract construction	1.228	1.226	1.259	1.293
Ordnance & accessories	1.078	1.108	1.208	1.209
Lumber & wood products	0.896	0.862	0.821	0.825
Furniture & fixtures	0.919	0.893	0.838	0.813
Stone, clay, & glass products	1.001	0.995	1.031	1.018
Primary metal industries	1.151	1.198	1.221	1.230
Fabricated metal products	1.060	1.085	1.096	1.084
Machinery	1.136	1.173	1.165	1.202
Electrical equipment	1.026	1.000	1.011	0.969
Transportation equipment	1.162	1.210	1.242	1.267
Instruments & related products	0.989	1.030	1.040	1.010
Miscellaneous manufacturing	0.904	0.873	0.827	0.791
Food & kindred products	0.920	0.901	0.959	0.925
Tobacco manufactures	0.689	0.675	0.723	0.758
Textile mill products	0.822	0.754	0.708	0.731
Apparel & related products	0.822	0.691	0.627	0.613
Paper & allied products	1.030	1.019	1.060	1.063
Printing & publishing	1.226	1.167	1.147	1.092
Chemicals & allied products	1.041	1.053	1.150	1.118
Petroleum & related products	1.304	1.282	1.322	1.288
Rubber & plastic products	1.004	1.031	1.031	0.995
Leather & leather products	0.773	0.722	0.674	0.667
Wholesale trade	1.009	0.978	1.011	0.990
Retail trade	0.784	0.705	0.695	0.611

Source: Computed from *Manpower Report of the President*. Table C-6, "Gross Average Weekly Earnings of Production or Non-Supervisory Workers on Payrolls of Selected Industries Annual Averages."

percent of the all manufacturing average earnings). By 1966, this ratio for tobacco was 76 percent, and tobacco manufactures were fifth from the bottom in weekly earnings.

Some of the declines in relative weekly earnings were really substantial. Earnings in apparel fell from 82 percent to 61 percent of the average of all manufacturing, furniture from 92 to 81 percent, leather from 78 to 67 percent, textiles from 82 to 73 percent, and lumber from 90 to 83 percent. In addition, retail trade fell from 78 to 61 percent and miscellaneous manufactures from 90 to 79 percent.

The seven industries that ranked from eleventh (paper and allied products, relative earnings 103 percent) to seventeenth (food, relative earnings 92 percent) in 1948 tended to show but slight changes in their relative earnings in the period to 1966. The relative earnings of electrical equipment dropped 6 percent; all the others remained approximately unchanged in relative earnings: that is, the terminal-year relative earning was ± 3 percent of the initial relative earnings.

Thus, over the period 1948–1966, for the industries examined, the rich tended to get richer, the poor tended to get poorer, and those in the middle tended to hold their own.

If 1948–1966 is broken into three subperiods, 1948–1953, 1953–1960, and 1960–1966, the spreading of relative weekly earnings and the thinning out of the middle range occurred during each period, although it has occurred at an accelerated rate since 1953. Whereas weekly earnings in 18 industries in 1948 were in the middle range (80 percent to 119 percent of the average in all manufacturing), 17 industries in 1953, 15 industries in 1960, and 13 industries in 1966 were in this range (Table 2).

Table 2. Average weekly earnings in 21 manufacturing industries, mining, construction, and trade: distribution of relative wages (all manufacturing = 100), 1948, 1953, 1960, 1966

Weekly wage as a percentage of all manufacturing	Number of industries			
	1948	1953	1960	1966
120.0 and over	4	3	5	6
110.0–119.9	3	5	4	2
100.0–109.9	8	6	7	5
90.0– 99.9	4	3	1	4
80.0– 89.9	3	3	3	2
70.0– 79.9	2	3	2	3
69.9 or less	1	2	3	3

Source: Table 1

The increase in the spread since 1948 seems to be mainly due to the relative retardation in the increase in earnings in what were already low-wage industries. The relative retardation of what were two high-earning industries in 1948—mining, and printing and publishing—is perhaps mainly due to technological changes, although the relative retardation of earnings in mining is a part of today's rural poverty scene.

Many of the industries in which relative wages declined between 1948 and 1966 were "sick" for part or all of this period. In the case of the textile, apparel, leather, and furniture industries, one response to difficulties was a rather large-scale migration from major metropolitan centers and their historical areas toward small towns and the South.

A theorem seems to fall out of the experience of the postwar period. Marked declines in relative wage earnings in an industry will be accompanied by changes in the location of the plants in the industry.

The maintenance, or even a continuation of the thinning-out trend, during the expansion of 1961–1966 is evidence that the supply curves of labor to the industries with low relative wages remained highly elastic as the overall unemployment rate decreased. This may reflect their locational

advantages: with rural areas as a continuing source of labor, the advantageously located low-wage industries may in fact be operating with a huge reservoir of labor, responsive to job opportunities at unchanging mark-ups over rural incomes.

As measured by the coefficient of variation, the spread of hourly earnings decreased slightly between 1960 and 1966, after increasing between 1948-1953 and 1953-1960. In spite of this, the coefficient of variation for weekly earnings increased between 1960 and 1966. Thus, hours worked were positively correlated with earnings so that the distribution of weekly earnings had a wider range than the distribution of hourly earnings. Inasmuch as it is earnings over a period, not the hourly rate, that is important in income distribution, the minor drawing together of hourly rates that occurred during the expansion is not especially significant.

Leading Sectors in Generating Aggregate Demand and Income Distribution

Aggregate demand has a structure which, in turn, generates the particular (including regional) demands for products and factors. The government impact upon aggregate demand also has a structure. As long as income distribution is a "minor" or, better, an "unmentionable" policy goal, then the impact upon income distribution of the particular structure of government programs can be ignored. Once the achievement of some maximum inequality becomes a recognized social imperative, then the way in which government affects income distribution becomes a factor in policy decisions.

A number of factors have combined to create the "shortages in the midst of surpluses" labor markets of the past 10 to 15 years, and the resultant spreading of relative incomes. One has been the peculiar pattern of government demand. It is only necessary to note how government spending on research and development has grown and to combine this with the growth of spending on education to recognize that leading sectors, in terms of the growth of aggregate demand, have generated initial demand for highly skilled professional and technical labor. Even though to a large extent the impact of government has been of a stop-go nature, the research-plus-education growth has been fairly steady.

A second factor in determining the changes in relative incomes has been the rapid migration from rural areas, in particular the movement of Negroes from the rural South [7]. This has generated a large—nay, an infinitely elastic—supply of unskilled and semiskilled workers in the cities. The disturbing results reported by Batchelder [2], that Negro male incomes deteriorated relative to white male incomes between 1950 and 1960 within the relevant cells, indicates that the data on average wages by industry may obscure increasing spreads of incomes within each industry.

A third factor tending to spread relative earnings has been the stop-go nature of many facets of the economy since World War II. Over this period, on the whole, the American economy has done well. However, this overall "smoothness" has been the result of a series of stop-go developments in various sectors. Not only has the country engaged in two "minor" wars, but also the leading sectors have shifted with great rapidity from general defense, to missiles, to space, to private investment. Each time a new government program, be it highways or aid to education or moon shots, gets under way, local excess demand for labor is generated.

The impact of new leading sectors upon wages is different from a rise in employment that takes the form of rehiring previously employed workers and from the expansion of conventional industries. Whenever local demand for labor exceeds supply, wages rise [5, 10]. In addition, wage increases in a sector spill over to other sectors, even in the face of overall labor market slack. This is so because productivity of labor is a function of "morale," and a decline in relative wages adversely affects morale. However, in the presence of slack, wage increases in the following sectors will be lower than in the leading sectors.

If a series of stop-go shocks occurs and if these shocks all have their major initial labor market impact upon a restricted set of labor markets, then the wage in this restricted set will rise relative to others. If these repeated impacts occur upon what are already high-wage industries and occupations, then the distribution of income will be adversely affected.

A test of whether the pattern of aggregate demand creation has affected the distribution of income, by a succession of such impacts upon the demand for particular classes of workers, is needed. Detailed occupational income data and a way of transforming each period's leading sector into demand for labor in particular categories are required for such a test.

Policy Suggestions

From the above, I extract two propositions relevant to policy formation:

1. The American economy as presently organized is not capable of achieving and sustaining tight full employment.
2. Within the employment limitations of the economy, there is no significant tendency toward a narrowing of the spread of relative income from labor.

I add to the above that a narrowing of the spread of income from labor is necessary.

If the post-World War II pattern of shifting leading sectors determining aggregate demand leads to perverse changes in the distribution of income, then we ought to consider changing the pattern of leading sectors.

A suggestion of real merit is that the government become an employer of last resort.

One attribute of such a tap employer is that, when the terms upon which it will employ are set, the minimum wage for all is determined. There is no longer any question about the "coverage" of minimum wage legislation. In addition, the minimum wage set in this manner does not have an adverse effect upon employment, as may be true for the present minimum wage legislation. The relative size of the wage set by the employer of last resort determines the division of the labor force between the private and the public sectors.

In a world where nominal wages are expected to increase each year, some improvement factor needs to be included in the terms upon which the employer of last resort hires. If the improvement factor for the employer of last resort rises at a faster rate than average and above-average wages, the range of relative wages decreases. In time, if such differential rates of change are sustained, a target ratio between the minimum and average can be achieved.

To the extent that the high-wage workers' nominal income rises at some "productivity rate," the low-wage workers' nominal income will need to rise at some faster rate: there may be an inflationary bias in an incomes policy that takes as one of its imperatives the achievement of greater equality. In addition, it will be necessary to restrain profits and investment; in particular, the highly destabilizing tendency for investment demand to explode will have to be brought under control.

Although we currently view the crisis in income distribution as centering around the urban ghettos, much of poverty is rural. An employer of last resort, willing and able to hire all who offer to work, will have a large impact on the poorer rural areas. One effect of such a national employment policy will be to slow down the pace of migration to the urban complexes. Inasmuch as many of the urban problems are related to the rapid rate of migration, such a retaining effect following from an employer of last resort will be an added virtue.

Much experimentation with tap employment policies, and its equivalent, the creation of programs which will have their major initial impact upon present unemployed labor, will be needed. However, the objective is clear: it is to take the labor force as it is and make sure that fitting jobs are available. Instead of the demand for the low-wage worker trickling down from the demand for the high-wage worker, such a policy should result in increments of demand for present high-wage workers "bubbling up" from the demand for low-wage workers.

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Discussion: Effects of Shifts of Aggregate Demand upon Income Distribution

W. H. LOCKE ANDERSON

Professor Minsky has ranged far and wide, making some fairly controversial pronouncements which he does little to support. I suspect that this is largely because so many are unsupportable. However, a paper of this sort opens to the discussant a rare chance to make his own unsupported statements in reply. I do not intend to let the chance slip by.

In analyzing poverty and planning a program to lessen its extent, it is useful to distinguish four types of poor people: (1) the physically or situationally unemployable, (2) the socially unemployable, (3) the employable unemployed, and (4) the poorly paid. Minsky's paper deals only with the fourth category. He contends, if I understand him correctly, that

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prosperity does little for the poorly paid; it benefits principally those who would be well off even if the economy were not booming.

It is hard to disagree with this proposition, but I would not be convinced by the evidence he presents in support of it. Group means followed over a period of time are very tricky when people are free to move into or out of the groups. If indifferently paid New England textile workers become well-paid electronics workers while poor southern share croppers become indifferently paid textile workers, should we really lament a widening wage differential between the two industries? What matters, after all, is what happens to individuals. It is easy to concoct examples in which the mean wage of a group falls from one year to the next even though everyone attached to the group in the second year has then a higher wage than he had in the first. The only way to find out what happens to individuals over the course of time is to follow the fortunes of individuals. Panel surveys may be costly and require patient researchers but there are no quick and cheap substitutes for them.

Suppose, however, that a carefully contrived piece of research did reveal, as seems likely, that gorging the jackasses is a very inefficient and uncertain way of getting grain to the sparrows. What sorts of institutions would we like to develop as supplements to the private economy so as to provide an income distribution consistent with our democratic ideals, not to mention "domestic peace and tranquillity"?

First, there is the problem of the physically and situationally unemployable—the aged, the unwell, and the female household heads with infant children. The answer for them is simple: give them money. Since the needs and situations of such people are so variable, it seems inevitable that much such assistance must continue to be distributed through casework welfare.

Second, there is the socially unemployable group—the poorly educated and the socially maladjusted who are yet reclaimable. For these we need to do much more than we do now in the way of combined maintenance and human development programs. One hopes that the aid of private business can be enlisted in such endeavors through the judicious use of tax credits or subsidies for training expenses.

Third, we have the employable unemployed. I fail to see how this group can be very large with adequate aggregate demand. What pass for the present as the unemployed must to a considerable extent be unemployables. To use their unemployment as evidence that demand strong enough to produce inflation is still too weak to eliminate unemployment is simply to becloud the issue. It does seem, however, that new entrants are likely to remain problem cases even in prosperity. We need for them an unemployment compensation system which does not make prior servitude a condition for receiving benefits.

Suppose we had really adequate programs to care for those who cannot be unemployed and to assure adequate training and opportunity to those who can. Would we still have a poverty problem? Would we still be faced with the cases in my fourth category—people who have been educated to the extent of their abilities, who are working, but who are so unproductive that they cannot earn a decent income? I do not know, nor do I know how one could find out except to get there and see.

However, I am convinced that if low pay arising from low personal capacity were to remain a persistent problem, we would have no need of Minsky's governmental "employer of last resort." I see no reason why a person who could work for a private firm and have his wage supplemented by a negative income tax should prefer to work for the government at the same income. We should aim for employment of all and an equitable income distribution, not an equitable wage distribution. A WPA seems likely to have much greater real resource costs than those arising from the disincentives of the negative income tax. Moreover, it would be criminal to create a class of salient second-raters in the name of humanizing the income distribution.

Farm Labor Mobility, Migration, and Income Distribution*

DALE E. HATHAWAY AND BRIAN B. PERKINS

THE heavy incidence of low incomes in agriculture has been highlighted again by the recent report by the President's National Advisory Commission on Rural Poverty [9]. One of the solutions long advanced for the low-income problem among farm people is increased rates of transfer of labor from farm to nonfarm employment. This solution is still advanced as the most obvious one, even though the high exodus rates of the past apparently have not resulted in changing either the income distribution within agriculture or the relative income position of farm and nonfarm people [3, 4, 5].

Given the belief that high rates of labor mobility will tend to reduce both interarea and interpersonal income inequalities, how does one explain the lack of improvement in light of the rapid out-movement that has occurred? One explanation put forth has been that insufficient aggregate nonfarm demand for labor backs up labor in agriculture. A second explanation has been that, because of a variety of impediments, the out-movement to nonfarm employment simply has not been fast enough.

Implicit in the model underlying these inferences are a number of assumptions:

1. A substantial part of the farm labor force, given their present skills and abilities, would earn more if employed in nonfarm jobs.
2. The potential nonfarm earnings of farm workers are unrelated to their earnings while farm-employed; as a corollary, farm workers with the lowest earnings have the greatest incentive to leave the industry.
3. Lack of information about nonfarm job opportunities and unemployment in nonfarm labor markets impedes the rate of farm to nonfarm mobility; in addition, farm operators are deterred from changing jobs by anticipated losses on equity capital. These impediments combine to reduce the opportunity cost estimates of the farm employed and to make them relatively immobile, and tend to confine their attention to local labor markets.
4. Maintenance of full employment is a sufficient condition for accelerating the reallocation of labor between agriculture and other industries, thus removing existing disparities between farm and nonfarm earnings and improving the income distribution of the farm employed.

* Certain data used in this study were derived from information furnished by the Social Security Administration. The authors did not have access to nor did they receive information relating to specific individuals or reporting units.

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The development of this explanation of farm labor mobility has been conditioned severely by data deficiencies. Little has been known about the returns to mobility out of agriculture, about the characteristics of movers and of those remaining in farm employment, about the relation between mobility and migration, or even about the magnitude of the gross movement out of, and into, the farm work force.

Our purpose in this paper is to examine critically the adequacy of the accepted farm-nonfarm labor mobility model and the conclusions inferred from it. This assessment is based primarily on the findings of our research into the mobility of farm labor, in which we used data derived from Social Security records. The continuous-register feature of Social Security data conferred a unique advantage, in that the employment and earnings experience of individuals could be traced from year to year.¹ In our opinion, time series which provide data on net labor force shifts are of limited usefulness and can be misleading. Altogether, our research has covered the years 1955 through 1963. Space limitations prevent presentation of most of the statistical results which underpin our findings, but these details may be found in other published reports [6, 8].

A final point of introduction is necessary. The terms *mobility* and *migration* are often used synonymously. We have developed rather precise operational definitions of these concepts which, to avoid ambiguity, should be made explicit. Individuals who had farm employment coverage in a given year were classified as farm workers; those with exclusively nonfarm employment coverage were classified as nonfarm workers. A change from any form of farm employment in one year to exclusively nonfarm employment in the following year was termed off-farm mobility; the reverse movement was referred to as in-farm mobility. Five categories of farm workers were identified: wage workers, farm operators, multiple job wage workers (that is, those who had both farm wage and nonfarm employment in the year), and multiple job operators with either nonfarm wage or nonfarm self-employment. Distance migrated was measured as the direct mileage between population centers of the county of farm employment and the county in which the mover's nonfarm job was situated. If this distance was 50 miles or less, the individual was not classified as a migrant, because such an individual typically could and often would commute without changing his residence.

The Returns to Mobility out of Agriculture

Central to the explanation of labor mobility is the hypothesis that its *raison d'être* is the expectation of higher long-run earnings. If disparities in earnings between farm and nonfarm jobs exist, most off-farm movers

¹ For details of the Social Security data on farm employed persons, see Hathaway and Waldo [7].

would experience immediate gains, although some might experience losses attributable to mobility decisions made under imperfect knowledge. It would be presumed that short-run and long-run gains would be highly correlated and that movers would tend to reassess their long-run expectations in the light of initial experience. Consequently, the stability of the occupational change would be closely related to both short- and long-run income change.

Our analysis of the period 1957-1960 revealed that close to one-half of the persons changing from farm to nonfarm employment in a given year sustained a loss in earnings (Table 1). The average gains were surprisingly low and the variance was considerable. This is consistent with data for earlier years and substantiates other evidence that many persons employed in agriculture cannot expect to achieve higher earnings in the nonfarm labor market.²

Table 1. Proportion of mobile persons experiencing gains and losses the first year after leaving farm employment

Mobility period	Mean gain in earnings in dollars	Loss over \$499	Loss \$1-\$499	Gain \$0-\$499	Gain \$500-\$999	Gain over \$999
		<i>percentages</i>				
1957-58	\$ 36.73	26.3	21.9	22.6	11.7	17.5
1958-59	233.62	22.7	18.4	20.5	13.8	24.6
1959-60	212.20	22.1	20.0	20.9	14.1	22.9

Source: Computed from Social Security data

With a view to identifying the characteristics of movers associated with high and stable returns to mobility, multiple regression analysis of short-run gain, mean earnings, and occupational instability³ in the years after the mobility period, using several variables of hypothesized importance, were undertaken for the coterminous United States and for five regions within it. Our choice of variables was necessarily conditioned by data availability, but we were able to examine the influence of age, race, farm employment status, initial income, proximity to employment centers⁴ prior to mobility, the major industry entered by the mover, and the distance he migrated.

² Ben-David [1, pp. 157 ff.] concluded that a major portion of those employed in agriculture in 1960 were earning as much as or more than their potential earning in nonfarm employment.

³ The individual's employment status in each year after initial mobility was ranked from "no covered employment" through "exclusively farm employment" and "multiple job-holding" to "exclusively nonfarm employment"; the absolute value of year-to-year changes in rank were summed, and this number was used as an index of instability.

⁴ The Standard Metropolitan Statistical Areas (SMSA's) were identified as the major nonfarm labor markets.

While age is not considered in the typical aggregative study of farm labor, many mobility studies have demonstrated its importance. Older movers were presumed to encounter more difficulties in obtaining and holding a job, and to have relatively lower earnings if they did secure nonfarm employment.⁵ These difficulties appeared to be evinced strongly in our analysis of the experience of movers. Both short-run gains and long-run earning levels were significantly lower for farm workers over 44 years old, while occupational instability rose exponentially with age.

It was expected, given their typically lower level of formal education and skills, together with probable discrimination in the labor market, that both the immediate gains and long-run earnings of Negroes would be lower than for whites. This was clearly substantiated by our analysis. Surprisingly, however, the employment stability of Negroes after leaving agriculture was not significantly lower than for whites. We concluded, therefore, that the low long-run earnings of Negroes is a question of preparation for and access to higher-paying jobs rather than being marginal workers subject to high frequency of lay-offs.

The level of earnings and occupational stability of movers were significantly and positively related to their total initial earnings. Indeed, the increase in long-run earnings was more than proportional to the initial level. The relation of short-run gains to initial earnings was more complex: movers with very low initial earnings predominantly experienced small losses and gains, while those with relatively high earnings had a high proportion of heavy losses (Table 2); however, those with the heaviest losses exhibited higher long-run earnings than both the small losers and small gainers (Table 3). Given their very low initial earnings, the experience of the first group was not unexpected. It is probable that farm workers with higher earnings in farming were in a position to take more risks and were

Table 2. Change in earnings of farm-nonfarm movers between 1957 and 1958

Earnings in 1957	Change in earnings from 1957 to 1958					Total
	Loss over \$499	Loss \$1-\$499	Gain \$0-\$499	Gain \$500-\$999	Gain over \$999	
	<i>percentages</i>					
Under \$1,200	9.7	29.9	30.7	13.6	16.1	100.0
\$1,200 to \$1,799	34.3	20.6	16.2	9.3	19.5	100.0
\$1,800 to \$2,399	33.3	13.6	19.3	12.8	21.0	100.0
\$2,400 to \$2,999	39.2	12.7	14.9	12.9	20.3	100.0
\$3,000 and over	46.1	14.0	15.5	8.5	15.9	100.0
All mobile workers	26.3	21.8	22.6	11.7	17.6	100.0

Source: Computed from Social Security data.

⁵ Gallaway shows this to be the case for hired farm workers [4, p. 46, Table 4].

Table 3. Short-run change and long-run earnings of mobile workers

Mobility period	Change in earnings the first year after mobility				
	Loss over \$499	Loss \$1-\$499	Gain \$0-\$499	Gain \$500-\$999	Gain over \$999
	<i>..... average annual earnings after mobility</i>				
1957-58	\$2223	\$1755	\$2087	\$2564	\$4021
1958-59	2132	1653	2000	2509	3862
1959-60	2217	1628	2077	2565	3941

Source: Computed from Social Security data.

more willing to do so, with the knowledge that they could return to a tolerable income in farm employment if their experience on leaving the industry proved adverse. Thus, the mean relation between initial earnings and immediate changes in earnings was negative. In the absence of data on the usual proxies for measuring skills, earnings while farm-employed were interpreted as a gauge of skills. Since this variable proved to be a significant positive factor relating to occupational stability and long-run earnings of movers, it must be concluded that the characteristics which determine an individual's earnings in agriculture are likely to have a similar effect in nonfarm employment.

The influence of the employment status of farm workers on their off-farm mobility returns also was significant. Those movers who had combined nonfarm wage jobs with their farm employment exhibited greater occupational stability after leaving agriculture, although somewhat lower long-run earnings. Experience, and possibly seniority, in nonfarm jobs appear to have benefited off-farm movers through continuity of employment. In view of the modest incomes of most of these individuals, it is to be expected that they placed a high premium on such security. At the other extreme was the relatively small group of multiple-job farmers with non-farm self-employment who, on leaving farming, experienced high initial gains and long-run earnings, but less occupational stability.

The proximity of farm workers to nonfarm job centers proved to be a significant determinant of mobility returns. Farm workers located within 50 miles of an SMSA exhibited higher gains and earning levels than other workers on leaving agriculture. Beyond this perimeter, however, the returns to mobility were not related to initial location. Consistent with these findings, distance migrated had no effect on either short- or long-run gains. The inference apparently is that the advantage enjoyed by workers close to urban labor markets was in terms of access to employment opportunities; such workers undoubtedly had better information on labor market conditions and a wider choice of jobs, and probably had more experience in nonfarm employment. A related variable was the median income

level of the county of farm employment. This variable was not included in the multiple regression analyses, but cross tabulation indicated that farm workers from low-income counties had lower gains and more occupational instability on leaving agriculture.

The experience of movers varied also according to the nonfarm industry they entered. Those who found jobs in government and, to a lesser extent, in retail and wholesale trades had lower gains, while workers entering manufacturing experienced both higher monetary returns and less occupational instability. These contrasts probably resulted from differences in the qualifications required for employment in government and in manufacturing. Government jobs were the main source of employment for older farm operators and are thought to have been mainly in local units of government, whereas manufacturing was a major source of employment among young off-farm movers.

In summary, it is clear that off-farm movers with certain characteristics experienced higher returns and greater stability of employment than other movers. The incentives for mobility into nonfarm jobs appeared greater for farm workers who were young and non-Negro, had relatively high earnings in farming, had experience in nonfarm jobs while farm-employed, were located within 50 miles of an SMSA, and came from a high-income county. Given these differences in incentives, one would expect mobility out of agriculture to be a highly selective process but not necessarily selective in the fashion generally postulated.

The Rates of Mobility out of Agriculture

The belief that nonfarm unemployment and lack of knowledge of nonfarm job opportunities severely inhibits mobility to nonfarm work is not supported by our analysis. On the average, an astonishing 14 percent of the farm work force changed to exclusively nonfarm employment each year. The fact that the observed rate of decline in farm employment has been very much lower is explained by a very high rate of mobility *into* agriculture: the ratio of in-farm movers to off-farm movers averaged about 9 to 10. Consequently, our hypothesis concerning the selectivity of mobility was tested on both off-farm and in-farm movements.

As in the analysis of returns to mobility, multiple regression analysis was used to determine the net influence on off-farm mobility rates of characteristics of individuals or of their county of employment.⁹ In effect, our equations provided estimates of the probability of off-farm mobility associated with each attribute. These estimated probabilities strongly con-

⁹ Whereas in the regressions of mobility returns the unit of observation was an individual mover, here the observation unit was a group of farm workers with specified characteristics and the dependent variable was the proportion of the group which moved into nonfarm occupations.

firmed our mobility hypotheses. In general, age and initial employment status proved to be the most important determinants of off-farm mobility rates. Mobility rates declined markedly with age. After age 44, mobility rates become very low and the differences between groups above that age were seldom significant. Farm workers who also had nonfarm jobs had much higher off-farm mobility rates, indicating that multiple job holding typically is not an alternative to off-farm mobility or a means of insuring against instability in nonfarm employment but is rather a stage in the process of leaving agriculture in which individuals obtain training in, and information about, nonfarm jobs. However this conclusion should be qualified in the case of farm wage workers, among whom there was a significant proportion of seasonal, casual, and migrant workers who appeared to have little commitment to any occupation and exhibited a highly unstable pattern of employment. Farm operators had significantly lower mobility rates than wage workers, consistent with the view that ownership of farm assets has served to reduce the mobility of farmers. But whether mobility was lessened because of the prospect of capital losses or because of the prospect of foregoing future capital gains, or because of stronger community ties among farmers, is not clear.

Negro farm workers overwhelmingly were hired laborers and were heavily concentrated in the South.⁷ Consistent with the evidence on mobility incentives, Negroes exhibited a *lower* off-farm mobility rate than non-Negroes. The apparently opposite finding in other studies of racial mobility is attributable to the failure of those studies to allow for the much higher proportion of young persons and wage workers among Negroes and to the fact they generally have measured migration, not mobility. The lower mobility rate of Negroes might be attributed to racial skill differentials, but since our analysis was specifically between Negroes and whites in the same farm employment category and in the same region (the South), we believe that an element of discrimination in labor markets is involved. This also would account for the higher migration rates to be discussed later.

The evidence on returns to mobility indicated that the distribution of short-run gains favored low-income farm workers but that in the long-run such individuals experienced lower earnings and more instability than other movers. The appropriate hypothesis regarding mobility rates deducible from this evidence is not clear. In fact, the earnings of the farm employed had no significant influence on their off-farm mobility rates. The hypothesis that off-farm mobility rates are negatively related to income levels has been based partly on migration data for high- and low-income

⁷ The South was defined as West Virginia, Virginia, Kentucky, Tennessee, North Carolina, South Carolina, Arkansas, Louisiana, Missouri, Alabama, Georgia, and Florida for this analysis.

farming areas [2]. We examined the notion that mobility rates were affected by local economic conditions by comparing counties (*a*) according to their proportion of commercial farms⁸ and (*b*) according to the median family income and percentage of rural population. Off-farm mobility rates were lower in low-income counties and, with some regional exceptions, in counties with the least commercialized agriculture. Inclusion of a variable which took account of both family income levels and the degree of rurality in a multiple regression analysis, indicated that persons in the most rural, low-income counties did not exhibit greater off-farm mobility than those in other areas.

Farm workers located within 50 miles of an SMSA had higher off-farm mobility rates than other workers, but in the main these differences were not statistically significant.

Examination of mobility into agriculture strengthens our assertions regarding the net effects of labor mobility. Because the Social Security data used for our research did not provide information on the entire nonfarm labor force, it was not possible to estimate the probability of nonfarm workers of given characteristics taking farm jobs. However, it was possible to establish that the great majority of in-farm movers had previous farm work experience, and this observation prompted us to examine the incidence of movement into agriculture relative to the number of off-farm movers with given attributes. This analysis confirmed our hypothesis that the characteristics of individuals which determine the probability of their initial movement out of agriculture also determine their chances of remaining in nonfarm employment. Thus, the highest relative incidence of back-movement occurred among older workers, Negroes, and farm operators, and into counties which had the least commercialized agriculture and the lowest family income levels, and, with some exceptions, which were more remote from large urban areas. The rationale for mobility into agriculture must have been largely economic. Those who returned to farm work had had both lower rates of pay and more unemployment in their nonfarm employment than out-movers who remained in nonfarm jobs, and on the average in-farm movers experienced immediate increases in earnings when they returned to agriculture.⁹

The Incidence of Migration

The crucial importance of local labor markets to farm workers is evident in the fact that two-thirds of those who changed from farm to nonfarm employment did not migrate.

Those characteristics of the farm employed which were associated with

⁸ Defined as farms with sales of \$10,000 and over.

⁹ Rates of pay were computed by calculating the earnings per quarter of covered employment during periods of nonfarm coverage.

high off-farm mobility rates were associated also with a high propensity to migrate. The proportion of movers who migrated, especially over long distances, declined with age and was high among farm wage workers; an exception to the generalization was that Negroes, who had relatively low mobility rates, were more frequently migrants. Migration, particularly long-distance migration, was less common in low-income areas and in areas lacking a commercialized agriculture. In other words, farm workers in such areas are those who rely most heavily on local labor markets for nonfarm job opportunities. Consonant with this finding, those with farm employment closest to large urban areas had a high propensity to migrate.¹⁰ Only in part are these relationships between location and migration attributable to the concentration of farm wage workers around SMSA's and in commercialized agriculture.

More than one-half of all migrant movers found employment in places with populations of less than 50,000. Thus, even when farm people leave their local community for nonfarm employment, most of them do not go to the largest cities. But among those who went to cities of over one million, the proportion returning to farming was much lower than for the small labor markets. The obvious explanation was found in the relation between mobility returns and city size: both employment stability and long-run earnings increased with city size for migrants and nonmigrants alike.

The Impact of Unemployment

Although we were not able to study the effect of unemployment on farm labor mobility directly, we did examine mobility relationships over a period of years in which national unemployment rates varied. Much of our research was based on data for 1957-1963, a period characterized by relatively high unemployment rates in all years. Nevertheless, some important differences in mobility relationships between periods of rising unemployment and periods of stable or falling unemployment rates were apparent.

Sharp increases in unemployment resulted in fewer gains and more losses from farm-nonfarm mobility, so that the average gains were close to zero. Such recessions seem to have had the greatest impact on the fortunes of older workers and of those without previous nonfarm job experience. Although the major employment shifts in the period were in large

¹⁰ This is not necessarily inconsistent with the high rates of net out-migration from low-income areas shown in aggregate data. First, the net out-migration statistics report total population movements, including many not in the labor force because of age and lack of local employment opportunities, whereas we measured the mobility of employed persons. Second, many migrants from low-income areas may become rural non-farm residents in higher-income areas surrounding metropolitan areas, so that these latter areas show net migration even though the farm-employed in them have higher mobility rates.

industrial centers, the effects seemed most noticeable in the remote areas and especially in the South.¹¹

Recession substantially reduced average off-farm mobility rates and increased mobility into agriculture. The response to unemployment conditions of farm-employed persons who had nonfarm wage jobs was greater than that of other workers, apparently because they were better informed about nonfarm job opportunities. The rate of mobility out of agriculture among Negroes in the South was markedly lower in recession periods, mainly because of the greater dependence of southern Negroes on distant labor markets. Similarly, increases in unemployment rates significantly lowered the mobility of farm workers in the most rural, low-income counties relative to those in the more prosperous and urbanized communities.

Mobility, Migration, and Income Distribution

The belief that there is serious malallocation of labor between farm and nonfarm employment is hard to substantiate, at least under the labor market conditions of the period we investigated. If this malallocation had existed, it should have resulted in preponderant and large gains to farm-nonfarm labor mobility, and our analysis suggests that neither is true. These results, as a corollary, indicate that the earning capacity of farm people in nonfarm employment may have been over-estimated. This conclusion, of course, has extensive implications ranging from revisions of "parity" income to vastly expanded employment services.

Although a large proportion of farm workers experience losses on moving into other occupations, the rate of mobility out of agriculture continues extremely high. If lack of job information is a significant impediment to the reallocation of farm labor, its impact, like that of unemployment, is primarily on the success of movers in establishing themselves in nonfarm employment. Only seven out of ten off-farm movers remained in exclusively nonfarm jobs for at least two years, and the rate of back-movement into agriculture offsets 90 percent of the mobility out of the industry. If excess labor in agriculture is to be transferred to other employment, the success with which off-farm movers realize their objective, not the gross out-movement, must be increased.

Mobility out of agriculture is highest for the young, for whites, and for those from the more prosperous farming areas and from communities close to large urban labor markets. The income and employment experience of those who attempt to leave farm employment validate the economic rationale of this selection. Over the course of time, this selectivity alone will widen the gap in income between and within farm areas, the gap in age distribution between the farm- and the nonfarm-employed,

¹¹ See Ferkins and Hathaway [8, pp. 36-41] for a detailed analysis of these results.

and the gap in income between those located near large labor markets and those less favorably situated.

These effects are accentuated by the back-movement into farm employment of persons who do not succeed in improving their incomes. These are most likely to be the lower-income persons in agriculture, individuals from low-income areas, and Negroes. Thus, both forces tend to increase the income disparities between the affluent and the poor areas and to exacerbate the problems of rural poverty.

Available evidence on the distribution of income in agriculture substantiates these fears [3]. Modest postwar reductions in the inequality of the total distribution of incomes among farm-operator families appear attributable primarily to retirement of older farmers who were predominantly in the lower-income groups. Among the families of hired farm workers, no improvement in income distribution is evident.

The heavy dependence of farm workers on local labor markets, in part explainable in terms of strong noneconomic ties, is consistent with income experience of most migrants. To this generalization, Negroes are an exception, apparently because of discrimination in southern labor markets. Persons finding employment in large cities have greater employment stability and long-run earnings, and though few off-farm movers go to large cities directly, it is probable that many do so in a series of moves.

The picture, then, that emerges from our study of the mobility and migration process is much less favorable to the solution of farm income problems than the conventional model has suggested. The massive reduction in the agricultural labor force that we observe is a process of trial and error, and the errors have been very costly to hundreds of thousands of people individually and to society at large. Deficient aggregate demand for labor in the economy only magnifies the errors and their consequences but does not appear to be the basic source of them. We cannot conclude, however, that these results arise mainly from a disequilibrium or imperfection in nonfarm labor markets. This would not explain the strong relationship between earnings in agriculture and earnings in nonfarm employment after mobility. The explanation would appear to be a decline in demand for the nonfarm jobs for which farm workers, by virtue of their skills, typically are qualified. The problem of growing inequality may be as much a capital market as a labor market phenomenon. The relative ease of adjustment in large urban areas may well rest on the existence of ample and expanding nonfarm employment in industries with a high capital-labor ratio and high labor productivity.

In conclusion, some major changes must occur for the process of mobility out of agriculture to improve the relative incomes of farm workers and the distribution of income within the industry. Full employment is obviously a necessary, but not a sufficient, condition. Then, either the migra-

tion rate to our large cities must increase or employment in smaller urban centers in rural areas must be expanded. The problems of our major cities hardly recommend the former on either social or economic grounds. All those capable of acquiring them must be given the basic education and skills that will enable them to benefit from potentially greater productivity in nonfarm employment. And, finally, racial discrimination must be removed from the nonfarm labor markets before the movement of Negroes out of agriculture promises to reduce income inequity between the races. Hopefully, if these changes could be brought about, the actual effects of labor mobility would conform to the beliefs we have cherished so long.

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Discussion: Aggregate Demand Shifts, Labor Transfers, and Income Distribution

LOWELL E. GALLAWAY

The task of a discussant is easier than that of those who present original papers in that he does not have to assume responsibility for the conduct of the original research and all the compromises that such research so often entails. In short, he is free to second-guess without having to offer a substantive alternative to the presented paper. However, in other respects the discussant's task is more difficult. If he rather fully agrees with the original paper, what can he say other than "me too" with some slight reservations? Or, if he disagrees markedly with it, the time he has at

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his disposal frequently is not sufficient to enable him fully to chronicle his misgivings. I find myself today in both of these difficult positions. To begin, my primary responsibility is the paper of Professors Hathaway and Perkins, which I feel is a solid, workman-like inquiry into patterns of farm-nonfarm movement of human resources. They have used their data well and have generally attempted to test certain of the more commonly stated hypotheses that have been advanced to explain movement of human agricultural resources. Consequently, I am going to confine my remarks on their paper to a brief appraisal of their major conclusions before turning to Professor Minsky's paper, with which I take sharp issue.

Probably the most significant aspect of the Hathaway and Perkins paper is the challenge it offers to the conventional wisdom that there is "serious malallocation of labor between farm employment and nonfarm employment." The essence of their argument is that "if this malallocation exists, it should result in frequent and large gains to farm-nonfarm mobility," and their analysis indicates that this does not happen. On the basis of this, they speculate that "these results [do not] arise mainly from a disequilibrium or imperfection in nonfarm labor markets." This suggests that the agricultural labor market may be, for the most part, in equilibrium with respect to the nonfarm labor market. On this point, I would basically agree with Hathaway and Perkins. Elsewhere, I have argued that what has frequently been interpreted as a situation of dynamic disequilibrium in agricultural labor markets may very well be one of dynamic equilibrium ["Mobility of Hired Agricultural Labor: 1957-1960," *J. Farm Econ.* 49:32-52, Feb. 1967]. However, beyond this point of basic agreement (which is certainly a fundamental one) I am not so certain that I agree with Hathaway and Perkins' contention that their analysis demonstrates a lack of imperfection in the nonfarm labor market. They base this conclusion on the presence of a strong relationship between earnings in agriculture and earnings in nonfarm employment after mobility. Myself, I find nothing in such a relationship which precludes the existence of sizable artificial barriers to farm-off-farm mobility. I presume that Hathaway and Perkins reason here that such barriers would have the same impact on all farm workers, regardless of their level of earnings in agricultural employment. However, it can be argued that artificial barriers to farm-nonfarm mobility would result in a consistent earnings differential between farm and nonfarm employment across all skill groups. This would be perfectly consistent with Hathaway and Perkins' data. Thus, on this count I find their arguments less than overwhelming. Despite this, however, I must conclude that they have generated useful evidence which does impart a substantial challenge to some of our habitual notions of how the agricultural labor market operates. Consequently, it is a useful contribution to our understanding of that market.

I turn now to Professor Minsky's paper. First, I note that the definition of poverty adopted by Minsky reflects a gradual evolution of the concept of poverty amid plenty. Originally, concern about the incidence of poverty in our society focused on the possibility that certain subgroups were not participating proportionally in the increasing affluence of our society. On the basis of this premise, the "backwash" thesis, it was argued that mere stimulation of aggregate demand was not an effective approach to eliminating poverty. Now, however, in the face of increasing evidence that economic growth does effectively shift people out of the poverty class, the "backwash" proposition has been redefined in such a fashion as to include low-income people who do not share *disproportionately* in the abundance of a growing economy. Consequently, the poverty problem as conceived by Minsky becomes one of imbalances in income distribution.

As he expounds upon these imbalances, Minsky focuses primarily on the distribution of wage income in the post-World War II period. The basic premises of his argument are (1) that the American economy is not able to achieve and sustain tight full employment (defined by Minsky as 3.0 percent), and (2) that there is no significant tendency toward a narrowing of the spread of relative income from labor.

The first premise is quite debatable. True, between 1953 and 1966 the full employment-unemployment rate rose from about 3.0 percent to 4.0 percent. However, the bulk of this increase has been concentrated among the age 14-19 group.¹ Outside of this age group, 1966 unemployment rates are reasonably comparable with those of earlier full employment years. Further, the increase in teen-age unemployment may well reflect nothing more than the impact on the labor supply side of the very high birth rates of the immediate post-World War II period. If this is the case, the observed increase in the full employment-unemployment rate which is fundamental to Minsky's first premise may prove to be a temporary phenomenon.

Minsky's second premise is perfectly acceptable. However, the value judgment he makes to the effect that its presence is undesirable and the policy recommendations he evolves from it are another matter. Put very bluntly, Minsky's notion of the government as an employer of last resort, who should exercise this function to narrow wage spreads while at the same time constraining private investment, amounts to nothing more than the "euthanasia of the private sector." The type of adjustment he envisages is the same as that which would occur with marked increases in the statutory minimum wage except that the unemployment generated in the

¹ In an unpublished manuscript entitled "The Rising Full Employment-Unemployment Rate" Zachary Dyckman finds that 60 percent of the 1.0-percentage-point increase in the full employment-unemployment rate between 1953 and 1966 occurred in the teen-age sectors of the labor force.

private sector would be absorbed in the public area. Minsky fully recognizes this, for he notes, "The relative size of the wage set by the employer of last resort determines the division of the labor force between the private and the public sectors."

Substantial questions may be raised as to how the adjustment mechanism posited by Minsky can operate to achieve his stated objectives. With the government pushing the wage structure from the bottom, what is to constrain monopolistic trade unions from stretching it at the top in the sense of "fairness?" If the federal last-resort wage rises by 10 percent, why should unions stop short of 10 percent, particularly if the federal government stands ready to mop up any long-run unemployment effects implicit in trade-union wage policies? In short, the narrowing wage spread Minsky so ardently desires may not be attainable through his formula of wage structure determination by government, short of *wage controls* in the high-wage sector. And, of course, this has implications with respect to price controls, etc. Clearly, the potential malallocation of resources implicit in the Minsky proposal is staggering to comprehend.

To sum up, the Minsky policy nostrums seem to offer two alternatives: (1) increasing governmental control of resource allocation (through wage, price, and, possibly, production controls) if his goal is to be achieved, or (2) very substantial rounds of true wage-push inflation as the employer of last resort attempts to narrow a wage structure which is based on such fundamental economic phenomena as (a) production functions, (b) relative supplies of labor, and (c) various monopolistic imperfections in the labor market, *without* attempting to alter the structural characteristics of the labor market.

Frankly, if these are the price of "domestic peace and tranquillity," I for one will opt for the riots to which Minsky obviously refers. However, I must say that I am not enough of an economic determinist to believe that the disturbances which affect our large cities almost every summer nowadays have such strong roots in the pattern of income distribution as Minsky implies. At any rate, even if Minsky is right in this respect, his price is too high for my taste.

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Central Banking and the Availability of Agricultural Credit

ANDREW F. BRIMMER*

IN APPEARING before this group of agricultural economists, I must necessarily come as a central banker rather than as an economist working on problems of agricultural finance. However, the fact that you invited me strongly suggests that the nexus between our respective concerns is being increasingly recognized.

In the following remarks, I shall focus primarily on the performance of the commercial banking system in the provision of agricultural credit. The central theme can be summarized briefly:

1. The restrictive monetary policy which the Federal Reserve found it necessary to follow in the national interest in 1966 had little direct impact on the short-term credit needs of agriculture although such credit is becoming increasingly sensitive to general credit conditions.

2. Several long-term trends are progressively impairing the ability of the banking system to finance agriculture. To check the relative decline of the banks in this field—and to enhance their role in the future—a number of critical changes are required: since the correspondent banking system is becoming less able to cope with the needs of large rural borrowers, restrictions on branch banking which exist in many farm states should be removed and the farm sector should have greater access to the national money market.

3. Within the Federal Reserve System, the re-evaluation of the discount mechanism now under way may result in the greater availability of seasonal credit for agriculture.

Impact of Monetary Policy on Farm Credit

In assessing the effects of monetary policy on the availability of agricultural credit, it is necessary to have a sense of history. Beginning in the midst of World War II, and for a long time thereafter, the aggregate supply of credit for agriculture was not a matter for great concern. The

* I am indebted to Emil Melichar of the staff of the Board of Governors of the Federal Reserve System for assistance in the preparation of this paper.

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amount of credit that agriculture used was effectively determined by the level of its demands.

In recent years, however, this situation has been gradually changing. The first restrictions on supply probably occurred as rural banks exhausted the liquidity they had built up during the war and in the immediate postwar years. Initially, the effect in each such case was a local one, but as more and more banks are reaching this position, a more pervasive impact is being felt.

The second constraint on supply was the reduction in farm lending activity by life insurance companies during periods of monetary restraint. At these times, high returns available on security investments tend to make this alternative temporarily more attractive than farm real estate mortgages. The resulting effect on farm lending was already evident during 1956-57, but it was more severe in the second half of 1966.

Finally, in 1966, restrictive monetary conditions (designed to combat inflationary developments in the economy as a whole) for the first time directly affected the operations of the federal land banks and production credit associations. As you know, demands for funds by business and governments in 1966 tended to exceed the supplies available, with considerable upward pressure resulting on interest rates. In May 1966, the federal government asked the Farm Credit Administration and other government-connected lending agencies to exercise restraint in making loans and thereby reduce the volume of securities they would have to sell to finance the loans. In September 1966, the request was strengthened. As a result, the Farm Credit Administration issued lending guidelines to both the land banks and the production credit associations, asking that loans not be made for speculative or postponable purposes but emphasizing that production and investment loans should receive high priority. These restrictions were lifted at the beginning of this year.

Thus, it is evident that the supply of farm credit is becoming increasingly sensitive to general monetary conditions. The impact so far, however, has been extremely small. With regard to production credit (where the needs are not postponable), year after year it has been the judgment of the Department of Agriculture, as published in the *Agricultural Finance Outlook*, that the supply of credit has been "adequate." With regard to 1966, it recently stated in the *Agricultural Finance Review*: "During 1966, non-real-estate farm debt . . . increased approximately 12 percent. . . . Farmers seem to have been served well with short- and intermediate-term credit during a period when some other segments of the economy were experiencing difficulties in securing adequate funds." With bank and production credit association farm loans up by another 12 percent in the first half of this year, it seems evident that such funds remain adequately available.

Outstanding farm mortgage lending by insurance companies and land banks also managed to expand during the second half of last year in spite of the difficulties mentioned above. Insurance company loans rose by 1.4 percent, substantially below the 5-percent average of other recent years, but an increase nevertheless. The land bank increase of 4.9 percent during the six-month period was not markedly different from the gains of previous years. In the first half of 1967, farm mortgages at insurance companies continued to expand, but at a slower rate than in previous years. Reports attribute this experience more to reduced farm demand, partly in resistance to the higher interest rates charged, rather than to reduced availability of funds. Federal land bank loans outstanding, perhaps assisted by a relatively favorable 6-percent rate, expanded by 7 percent in the first six months of this year.

Long-Term Supply and Demand for Farm Credit

While the aggregate supply of funds thus far has not been much of a limiting factor in farm credit use, the ability of the banking system to finance agriculture does appear to be increasingly impaired. This is due not so much to shifts in monetary policy as to a number of trends that have dominated the agricultural economy since the early 1950's.

The first of these trends is the relatively slow pace of expansion in the dollar value of total farm income-generating activity. Whether measured by gross marketings of farm products, by production expenses, or by net income, growth in such activity during the last ten years has not exceeded an annual average of 4 percent. The value of farm assets (including real estate valued at current market prices) has increased only slightly faster—at perhaps 4.5 percent annually.

In the many agricultural states in which the organization of the banking system is legally restricted to local unit banks, this modest expansion of the primary rural industry is logically reflected in the modest growth rate of these banks. As we know, banking resources in rural areas dominated by unit banks are derived primarily from the economic activity of the local community. It is not surprising, therefore, to find that the Department of Agriculture's index of total deposits at country banks in 20 agricultural states (primarily unit banking states) has increased at an annual rate of about 5 percent during the last decade. With the number of banks not greatly changed over this period, the average growth of individual banks has been roughly of the same magnitude.

But there is a second trend operating in the farm economy. This is the rapid growth in the size of individual farm firms, brought about through consolidation of units and through expansion of livestock enterprises. Average assets, marketings, production expenses, and net income per farm have all roughly doubled in the last ten years—an annual rate of increase

of about 7 percent. To finance these changes in the structure of agriculture, farmers as a whole more than doubled their outstanding debt during the decade, raising it by better than 8 percent annually. On an average per-farm basis, use of credit more than tripled, registering an annual rate of growth of 12 percent.

When we compare these growth rates in farm credit use with the growth rates estimated for the resources of rural unit banks, we can readily appreciate the growing uncertainty about the ability of such banks to continue meeting farm credit demands. By recasting the data cited above, we can put the problem into sharper perspective. We have seen total farm production activity expand by about 50 percent over ten years. Total deposits of rural banks have increased by somewhat more—by approximately 70 percent, according to the USDA index. Yet this is the principal source of funds for farm loans—and farm loans increased by about 120 percent. This is one of the horns of the farm finance dilemma faced by the banking system: farm credit demands in the aggregate are growing faster than total rural banking resources.

During the same ten-year period, we have seen average credit use per farm triple, while the average deposit size of rural banks has probably not quite doubled. This is the other horn of the dilemma faced by rural banks: their size (and thus the size of individual loans that they can comfortably or legally make) is increasing out of tune with the size of the credit requests made by their farm customers.

A more detailed look at farm finances reveals that the rapid expansion of total farm credit demands has arisen more from the need to finance the reorganization of agricultural production units than from increases in total capital requirements. This relationship does not appear to be fully appreciated, but it would seem pertinent here. If the farm finance problems of the banking system arise mainly from changes in farm structure, perhaps equivalent changes in banking structure are the most logical way in which to resolve these problems.

Increased aggregate investment in farm plant and equipment is frequently cited as the basis of increased credit demands. However, aggregate data for the farm sector show that this is not the dominant factor in recent credit demands. In every year since 1954, farm debt has increased by a greater amount than total net investment in farm plant and equipment. In 1966, for example, capital expenditures for farm structures, vehicles, machinery, and equipment were \$3.0 billion. Depreciation and other capital consumption of these items totaled \$5.2 billion. Thus, net investment was \$0.8 billion—the largest amount since 1953. However, farm debt increased by \$4.6 billion in 1966—or by about six times the amount necessary to finance the net investment. During the ten-year period 1957–1966, net investment totaled only \$2.5 billion. Yet total outstanding debt rose by

\$26.3 billion. The farm sector apparently incurred this debt mainly to finance transfer and expansion of individual enterprises and units, rather than to make net additions to its total productive plant.

Future Demand for Farm Credit

The foregoing discussion has concentrated on the large and pervasive expansion in farm credit use during the recent past. But what of the future? All who have studied this subject agree that future credit demands will continue to expand rapidly. For the next few years, the issue is not really in doubt, because the foundation for such demands is provided by technological advances that have already been discovered and remain to be applied. For example, already the optimum size of a family farm is apparently considerably above the present average, in spite of the rapid advance of the latter.

Actual quantities of future credit demands are, of course, much harder to foresee than the direction of change, but some projections have been made. These certainly indicate no slackening in the rate at which credit demands will grow. A study made for the National Advisory Commission on Food and Fiber projected a 35- to 40-percent increase in total farm capital and a doubling of average capital investment per farm—to \$123,000—between 1965 and 1980. John Brake, in a paper presented to your association last year, projected outstanding farm debt of \$100 billion in 1980, a rather startling round number but one that would be surpassed at the current rate of increase. This rise in debt, Brake estimates, would raise the debt-to-asset ratio in agriculture from the present 17 percent to about 28 percent in 1980. Use of credit in farming would then be approaching average levels currently found in nonfarm enterprises: debt-asset ratios average around 40 percent in manufacturing enterprises and near 50 percent in nonfinancial corporate business.

Future Supply of Farm Credit

With this future demand in mind, what about the position of the banking system as a prospective source of funds? On the basis of the present situation, the outlook is far from bright.

In spite of the general growth in farm credit demands, a surprisingly large number of rural banks have not been particularly eager to serve these needs in their own communities. This is shown by the relatively low loan-to-deposit ratios that many of these banks still have. At the time of our June 1966 farm loan survey, we found that 6,019 banks (44 percent of all banks) had one-fourth or more of their farm loan volume in loans to farmers. At 2,428 of these banks (or 40 percent of them), loan volume at that time was below 50 percent of deposits. At over a thousand of these banks, the loan-deposit ratio was below 40 percent; at 312 banks, it was

below 30 percent. The Federal Reserve Bank of Kansas City examined the location of the banks with low loan-deposit ratios in its district and found that the majority did not lack farm lending opportunities in their communities.

It seems evident that the disparity between bank size and farm size is destined to become an ever greater constraint on the ability of rural unit banks to meet credit needs in their areas. In some states where farms tend to be larger, it is already a common difficulty. In the 1966 Federal Reserve survey of farm loans at commercial banks, the annual dollar volume of individual loan requests exceeding the legal lending limit of the reporting banks totaled 7 percent of the farm loan volume outstanding at banks in the Northern Plains states on June 30. In the Mountain, Southern Plains, and Lake states, the ratio was 4 percent. High ratios were found in important agricultural states such as Kansas, Nebraska, Colorado, Minnesota, Oklahoma, and Texas.

Deficiencies in Correspondent Banking

When a bank receives an otherwise acceptable farm loan request that exceeds its legal lending limit, the textbook solution calls for it to arrange for one of its correspondent banks, usually a larger city bank, to participate in the loan to the extent of the overline portion. There is serious doubt, however, whether the participation technique has adequately handled the overline loan problem in the past. There is even greater doubt that it will provide an adequate solution to the larger problem foreseen for the future. It is true that many banks have used participation loans to the mutual benefit of themselves, their farm customers, and their correspondent banks. From 1956 to 1966, total participation loans outstanding increased sevenfold, and in June 1966, the total volume of outstanding loans being handled in this way was estimated at \$574 million, or 5 percent of total bank credit to farmers. Geographically, the distribution of these loans was highly correlated with the distribution of overline requests mentioned above.

However, these data represent the favorable side of the participation picture. On the other side, interviews with city bankers indicate that some make little or no attempt to make such arrangements for large customers of smaller banks, whose business may in that case go by default to a production credit association. To an even greater extent, interviews with city banks have shown that many regard the farm participation, not as a welcome and profitable lending opportunity, but rather as a relatively onerous service that competition for demand balances forces them to give to their country correspondents.

It is apparently fairly common for city banks to insist on receiving compensating balances equal to part or even all of the participation. This could make the servicing of an overline request a fairly expensive proposi-

tion for the small bank, and would tend to discourage meeting it. Also, such requirements indicate that participations may not constitute much of a net addition to rural lending resources. Finally, it is unlikely that attitudes of large city banks generally toward farm participations will improve much if the loan demand of their own customers stays at the levels indicated by recent loan-deposit ratios of these banks.

Need for Reorganization in Rural Banking

In my view, a more comprehensive solution for the areas in which growth in farm size is running away from growth in bank size would be to remove restrictions that currently tend to keep banks small. It is significant that the 1966 survey found virtually no overline problem in the Pacific states, where average farm size is far above the national average, but also where large-scale branch banking is permitted. Liberalization in other states of restrictions on branch banking would obviously tend to make resources of larger banks locally available to farmers that need them. It would also tend to resolve difficulties that small banks themselves are now having, such as the inability to pay salaries adequate to attract the better managers and to provide for management succession. In fact, in many ways, the small local unit bank is about as hard pressed as the small farm. To some extent, both are beneficiaries of public restriction of competition, and both face many of the same problems in our expanding economy and in our highly mobile society.

Modernization of the banking structure in key agricultural states presently restricted to unit banks would also constitute a direct attack on the second farm finance problem faced by the banking system—that of developing farm loan funds at a rate that matches the expansion in aggregate farm credit demands. So far, in the postwar period, banks have approximately maintained their share of total farm lending business. They were able to do so because they had accumulated a large amount of liquidity during World War II and in the immediate postwar years, during which the agricultural economy prospered and was paying off its indebtedness. Over the years since then, this cushion of loanable funds (which was mostly invested in government securities) has been sharply reduced in the banking system as a whole. In fact, it has been completely eliminated at many banks, including most large banks and also many rural banks. In the future, therefore, expansion of lending will have to be more closely related to expansion of total banking resources.

Tapping the National Money Market

In this circumstance, larger banks and branch banks possess several advantages that could be employed to expand the availability of loan funds for their farm customers. Large banks, for instance, are presently better able to tap national money markets through sale of certificates of deposit.

Banks with branches in both urban and agricultural areas can channel funds internally from the former to the latter, if this is where loan demands are exceeding deposit growth.

Still other ways have been suggested by which funds could be channeled from urban to agricultural areas through the banking system. One frequently mentioned consists of activating the 40-year-old provision that allows commercial banks to discount farm loans at the Federal Intermediate Credit banks, which as you know also perform this function for the production credit associations. It is sometimes forgotten that the FICB's were organized in the 1920's, before the PCA's existed, primarily to discount farm loans of banks. Both then and now, however, few banks made use of these facilities. Present provisions for discounting by banks do not provide material assistance to their farm lending operations, because the discounting is on a recourse basis and the outstanding volume is limited to twice the capital and surplus of the bank (as opposed to ten times capital and surplus for PCA's). Also, the requirement for examination of the bank by yet another agency is probably discouraging. But if these statutory provisions were liberalized, and if the FICB's openly encouraged bank use of their facilities and acquainted bankers with their procedures, then the intent of this long-standing legislation—to provide the banking system with a way to tap the national money market for farm loan funds—could at last become effective. Small banks, in particular, could thereby gain indirect access to a market in which they presently do not participate.

A number of agricultural banking leaders have recently suggested other ways in which rural banks could themselves organize to obtain access to national financial markets, either with or without assistance from federal agencies. For instance, perhaps certificates of deposit of small banks could be made more salable if they were insured. Instead of seeking participations in overlines, small banks could offer participations in a pool of such certificates. In addition, perhaps packages of farm loans, or participations in them, could be sold if insured or if credit-rated by some private or public agency. Such arrangements can materialize only through much effort by bankers and others, but perhaps such effort will be necessary to provide adequate farm financing through the banking system.

Modernizing the Federal Reserve Discount Window

Within the Federal Reserve System, there is currently in progress a major study and reappraisal of the role of the discount mechanism. Though not yet completed, this work appears to be indicating a number of ways in which improvement of Reserve Bank procedures for lending to member banks can serve better the needs of these banks under the conditions of reduced liquidity which many of them face. Of particular significance to rural banks, we have made extensive study of seasonal flows of funds. This study shows clearly that these in general tend to be of greater

relative magnitude at small banks in agricultural areas than at other member institutions. We have found that small agricultural banks are especially likely to experience a seasonal squeeze on funds through simultaneous withdrawal of deposits and expansion of loans. This is a general pattern in the spring and early summer, and it may often result in relatively inefficient use of banking resources in the areas in which it occurs. A bank subject to large seasonal fund outflows must necessarily maintain liquidity sufficient to meet them. During the off-peak season of the year, therefore, some funds that might otherwise have been committed to useful community financing—including the kind of intermediate-term loans particularly desired by modern farm managers—must instead be maintained in short-term government securities or other forms that can be readily liquidated to meet the seasonal flow.

But if a greater share of such seasonal demand could be satisfactorily met through borrowing from Federal Reserve banks, those funds would be released for other loan purposes in the community. We are examining how our discount regulations and procedures could be changed to accomplish this objective more effectively than at present while at the same time maintaining appropriate control of the overall reserve base of the banking system. You can appreciate that it is not simple to determine the definitions, criteria, borrowing limits, and safeguards against abuse that will be needed to expand our discount function in this way. Nevertheless, I am hopeful that it will be possible to take such a step soon, and I believe that it can be a significant one for rural banks.

Concluding Remarks

In these various problems that bear directly on the supply of bank funds for farm lending—the questions of unit versus branch banking, of banks that have funds but restrict their lending, of bank participation in funds obtained by the FICB's, of organizational or insurance arrangements that would permit small banks to sell their assets or liabilities in the national financial market, and of achieving greater effectiveness of the Federal Reserve discount mechanism—in all of these I suggest that there lie feasible and important opportunities for studies that are within the wide realm of agricultural economics.

I think it is fair to state that this area has been neglected in the past, but I am also pleased to see that its current importance is being increasingly recognized. In recent empirical work in which models of farm firm growth were developed, for instance, the importance of external financing is readily noted, and its effect on a farmer's financial progress is vividly demonstrated. Increased attention to study of rural economic development will undoubtedly lead directly to examination of rural financial markets and their impact on rural economic progress. We look forward to benefiting from your greater concern in these vital areas.

RECENT ECONOMETRIC ANALYSES IN AGRICULTURE

CHAIRMAN: GEORGE JUDGE, UNIVERSITY OF ILLINOIS

Estimation of Demand for Food and Other Products Assuming Ordinally Separable Utility

WALLACE K. BOUTWELL, JR., AND RICHARD L. SIMMONS*

ORDINAL utility theory has long recognized the mutual interdependence of a large number of consumer goods in the budget decisions of the individual consumer. However, the formulation of empirical models which explicitly recognize the simultaneity of the many price and income effects is difficult because of the number of parameters involved. In a budget of n goods there are n^2 price elasticities and n income elasticities. The symmetry of compensated price effects reduces the number to $\frac{1}{2}n(n+1)+n$. The Engel and Cournot elasticity aggregation relationships further reduce the number by $n+1$, leaving $\frac{1}{2}(n^2+n-2)$ parameters to be estimated. In view of the rather short span of available time-series data for some important categories of consumer goods, the estimation of so many parameters may be difficult. One could take a single-equation partial-equilibrium approach and eliminate many parameters by assuming their importance to be negligible. Examples of this approach are found in the many early works of Moore, Leontief, Marschak, Schultz, and Wold and Jureen. One of the difficulties in this approach is that although each individual omitted parameter may be negligible, their combined effect may not.

An alternative approach, taken in recent papers by Strotz [5, 6], Frisch [2], Pearce [4], and Barten [1] is that of postulating a utility function $U(X_1, X_2, \dots, X_n)$ for which one can specify particular effects on the marginal utilities $U_i = [\partial U(X_1, X_2, \dots, X_n)] / \partial X_i$ of certain goods in response to consumption changes in certain other goods. Several intuitively tenable postulated relationships have been defined which reduce the number of parameters to the desired level while still preserving most of the simultaneity of the system. Frisch assumes that the marginal utility of a good i is not affected by the level of good j , for all $i \neq j$. With $U_{ij} = 0$ for all $i \neq j$, all cross elasticities can be expressed in terms of income elasticities, a "money flexibility" term, and expenditure weights. Only $n+1$ parameters are necessary to solve the entire system.

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Barten uses the same assumption for some (but not all) U_{ij} 's and controls the number of parameters to n income elasticities plus n direct price effects plus Frisch's money flexibility term plus the number of cross price effects corresponding to the U_{ij} 's assumed to be not zero.

Strotz concluded that if the goods entering the utility function can be separated into groups I, J, K, \dots such that

$$(1.1) \quad \frac{\partial \left(\frac{U_i}{U_j} \right)}{\partial X_k} = 0 \quad \text{for } i \in I \\ j \in J \\ k \in K \quad (\text{with } K \neq I, J),$$

then all parameters in the system of n goods can be obtained by direct computation after all income effects, all intragroup price effects, and one intergroup cross price effect are known. This type of separability is termed "strong separability."

Strotz also defined but did not investigate "weak separability." Weak separability is defined as

$$\frac{\partial \left(\frac{U_i}{U_j} \right)}{\partial X_k} = 0 \quad \text{for } i, j \in G \\ k \notin G \\ G = 1, 2, \dots, N'.$$

Obviously, weak and strong separability differ only in the group positions of goods i, j, k , but Goldman and Uzawa [3] point out that strong separability implies an additive utility function whereas weak separability does not. Hence, weak separability is the less stringent assumption.

Pearce shows that if goods can be divided into groups such that

$$\frac{\partial \left(\frac{U_i}{U_j} \right)}{\partial X_k} = 0 \quad \text{for all } i, j \in G \\ k \neq i, j,$$

then each cross price effect can be stated in terms of the two income effects and a factor of proportionality, λ^{IJ} , which holds between the two groups I and J and is constant over all pairs of goods taken from the two groups. Thus, the number of parameters is reduced to $\frac{1}{2}N(N+1) + n$, where N is the number of groups and n is the total number of commodities.

Pearce's assumption requires that where there are more than two commodities in a group any two commodities within that group must be in "neutral want association" with all other commodities within that group.

Goldman and Uzawa show that this implies an additive utility function when there are more than two commodities in a group.

These brief statements on each of the four papers do not constitute a review of literature but do give some idea of the connection between reduction of parameters and stringency of assumption regarding the type of relationship existing between goods or groups of goods. (It is not meant to imply that these four authors were concerned solely or even primarily with a degree-of-freedom problem. Their papers contained other interesting propositions.) The assumptions of Frisch and Barten imply cardinal utility, whereas the assumptions of Strotz and Pearce are ordinal in nature.

This paper concentrates on those assumptions that are ordinal in concept and presents a procedure for deriving the implications in terms of restrictions on theoretical demand parameters of (1) weak separability between all commodity groups, (2) strong separability between all groups, and (3) combinations of weak and strong separability. All of this is accomplished with no restrictions on the number of commodities in any group, or on the number of groups, or on the relationship of commodities within a group.

Theoretical Demand Model

Differentiating the first-order conditions for utility maximization subject to a budget constraint with respect to prices, P_j , and income, M , and putting the results in elasticity form gives a system of elasticity relationship which can be written in the following form:

$$(2.1) \quad \begin{bmatrix} \epsilon & L \\ W' & 0 \end{bmatrix} \begin{bmatrix} \eta & E \\ -\phi & -\psi \end{bmatrix} = \begin{bmatrix} 0 & I \\ 1 & -W' \end{bmatrix}$$

where

ϵ is an $n \times n$ matrix of $\frac{\partial U_i}{\partial X_k} \frac{X_k}{U_i}$ terms,

L is an $n \times 1$ matrix of ones,

W' is a $1 \times n$ matrix of budget weights, $W_i = \frac{P_i X_i}{M}$,

η is an $n \times 1$ matrix of income elasticities,

ϕ is $\frac{\partial \lambda}{\partial M} \frac{M}{\lambda}$,

E is an $n \times n$ matrix of price elasticities,

ψ is an $1 \times n$ matrix row of $\frac{\partial \lambda}{\partial P_j} \frac{P_j}{\lambda}$ terms, and

I is an $n \times n$ identity matrix.

Since

$$\begin{bmatrix} \epsilon & L \\ W' & 0 \end{bmatrix}^{-1} = \frac{1}{W' \epsilon^{-1} L} \begin{bmatrix} W' \epsilon^{-1} L \epsilon^{-1} & -\epsilon^{-1} L W' \epsilon^{-1} & \epsilon^{-1} L \\ -1 & W' \epsilon^{-1} L + W' & -1 \end{bmatrix},$$

the income and price elasticities can be written as

$$(2.2) \quad \begin{bmatrix} \eta & E \\ -\phi & -\psi \end{bmatrix} = \frac{1}{W' \epsilon^{-1} L} \begin{bmatrix} \epsilon^{-1} L & W' \epsilon^{-1} L \epsilon^{-1} - \epsilon^{-1} L W' \epsilon^{-1} - \epsilon^{-1} L W' \\ -1 & W' \epsilon^{-1} L + W' \end{bmatrix},$$

from which the following relationships appear:

$$(2.3) \quad \phi = \frac{1}{W' \epsilon^{-1} L},$$

$$(2.4) \quad \eta = \phi \epsilon^{-1} L,$$

and

$$(2.5) \quad E = \epsilon^{-1} - \eta W' \epsilon^{-1} - \eta W'.$$

The ϵ matrix has certain useful symmetric properties (being derived from U_{ij} , which is symmetric). Specifically,

$$(2.6) \quad \epsilon_{ij} = \frac{W_j}{W_i} \epsilon_{ji},$$

which we call here "proportionally symmetric." From Theorem I, it follows that ϵ^{-1} has the same useful property.

Theorem I. The inverse of a proportionally symmetric matrix is also proportionally symmetric with the same factors of proportionality as the original matrix.

This can be proved by writing out $|M_{ij}|$ and $|M_{ji}|$ (the minors of ϵ_{ij} and ϵ_{ji} , respectively) and noting that $|M_{ij}| = W_i/W_j |M_{ji}|$. It follows that the cofactors C_{ij} and C_{ji} bear the same relationship; and since

$$\epsilon^{-1} = \frac{(C_{ij})'}{| \epsilon |},$$

then

$$(2.7) \quad \tau_{ij} = \frac{W_i}{W_j} \tau_{ji},$$

where τ_{ij} is the ij th element of ϵ^{-1} .

The proportional symmetry of ϵ^{-1} allows (2.5) to be written as

$$(2.8) \quad E = \beta - \eta W',$$

which is recognized as the Slutsky Equation, where

$$(2.9) \quad \beta = \epsilon^{-1} - \frac{\eta \eta' \bar{W}}{\phi},$$

\bar{W} is an $n \times n$ diagonal matrix of budget weights, and

$$(2.10) \quad \sum_i \beta_{ij} = 0 \quad \text{from (2.4)}$$

and

$$(2.11) \quad \beta_{ij} = \frac{W_j}{W_i} \beta_{ji} \quad \text{from (2.6)}.$$

Implications of Ordinal Separability Assumptions

The equation (2.8) has the usual $\frac{1}{2}n(n+1) + n$ parameters, but the number can be reduced by the assumption of ordinal separability, which is defined as

$$(3.1) \quad \frac{\partial \left(\frac{U_i}{U_j} \right)}{\partial X_k} = 0 \quad \text{for some } k \neq i, j.$$

The term "ordinal separability" is used here to include both weak and strong separability and various combinations of the two. The definition (3.1) accounts for this fact by not specifying the group locations of i, j, k .

The effects of the ordinal separability assumption can be determined by completing the differentiation implied by (3.1), which yields

$$(3.2) \quad U_j U_{ik} = U_i U_{jk}.$$

Rearranging (3.2) and multiplying by X_k gives

$$(3.3) \quad \epsilon_{ik} = \epsilon_{jk}.$$

The relationship (3.3) has interesting implications for ϵ^{-1} , which are derived from the following theorem.

Theorem II. If a nonsingular, square matrix, A , can be partitioned so that all diagonal partitions form nonsingular submatrices and all off-diagonal partitions contain columns whose elements are nonzero and equal, then the column elements of the off-diagonal partitions of A^{-1} are proportional to each other, with the factor of proportionality being the ratio of the sums of the two rows of A^{-1} in which the elements fall.

Thus, if $\epsilon_{ik} = \epsilon_{jk}$, then

$$(3.4) \quad \tau_{ik} = \frac{\sum_{t=1}^n \tau_{it}}{\sum_{t=1}^n \tau_{jt}} \tau_{jk}.$$

Substituting (2.4) into (3.4) gives

$$(3.5) \quad \tau_{ik} = \frac{\eta_i}{\eta_j} \tau_{jk} \quad (k \neq i, j).$$

By writing out ϵ and ϵ^{-1} using Theorem I and (3.5), it can be shown that when commodity i is not in the same group as k , all of the intergroup τ 's can be expressed as a function of a single intergroup term, say τ_{pq} , as follows:

$$(3.6) \quad \tau_{ik} = \left(\frac{\tau_{pq}}{\eta_p \eta_q W_q} \right) \eta_i \eta_k W_k \quad \text{where } \begin{array}{l} i, p \in I, \\ k, q \in K, \\ I \neq K. \end{array}$$

The term in parentheses does not vary with i or k and may be treated as a constant for all interaction terms between groups I and K .

Utilizing (3.6), we can write the Slutsky substitution term β , from (2.11), as¹

$$(3.7) \quad \beta_{ik} = \rho_{ik} \eta_i \eta_k W_k$$

where

$$\begin{aligned} \rho_{ik} = \rho_{IK} &= \frac{\tau_{pq}}{\eta_p \eta_q W_q} - \frac{1}{\phi} \quad \text{and is constant when } \begin{array}{l} i, j \in I \\ k \in K \\ K \neq I \end{array} \\ &= \frac{\tau_{ik}}{\eta_i \eta_k W_k} - \frac{1}{\phi} \quad \text{when } i, k \in I. \end{aligned}$$

It should be noted that $\rho_{ik} = \rho_{ki}$.

With equation (3.7), the complete set of cross price elasticities between commodities in group I and group K can be found by estimating ρ_{IK} and the relevant income elasticities.

Implications of Specific Types of Ordinal Separability

The implications of the different types of ordinal separability assumptions may be determined simply by specifying the group locations of i, j, k and retracing the steps in equations (3.1) to (3.7).

¹ Note that when $\tau_{ik} = 0$, as postulated by Frisch and Barten, the $\rho_{ik} = -1/\phi$.

Weak separability

$$\begin{aligned} \text{If} \quad \epsilon_{ik} &= \epsilon_{jk} \quad \text{for all } i, j \in G \\ &k \neq G \\ &G = 1, 2, \dots, N, \end{aligned}$$

then all commodity groups are weakly separable and the intergroup interaction terms can be expressed in terms of a unique ρ for each pair of groups. Thus, under the conditions of a weakly separable utility function, the complete set of price elasticities can be found by estimating n income elasticities, $\frac{1}{2}N(N-1)$ intergroup price elasticities (where N is the number of groups), and $\frac{1}{2}\sum n_G(n_G+1)$ intragroup price elasticities (where n_G is the number of commodities in group G). The Cournot and Engel aggregations can, of course, be used to reduce this number by $(n+1)$.

Strong separability

In the case of strong separability for all commodity groups where

$$\begin{aligned} \epsilon_{ik} &= \epsilon_{jk} \quad \text{for all } i, j \in G \\ &k \in G \\ &G = 1, 2, \dots, N, \end{aligned}$$

all intergroup terms can be expressed in terms of a single, common ρ . This permits the entire set of price elasticities to be found by estimating only one intergroup price elasticity, n income elasticities, and $\frac{1}{2}\sum n_G(n_G+1)$ intragroup price elasticities. Again, this number can be reduced by using the Cournot and Engel aggregations.

Combinations of strong and weak separability

The third type of ordinal separability assumption is that of combinations of weak and strong separability, which results from subgrouping within groups. An example of this case is where

$$\begin{aligned} \epsilon_{ik} &= \epsilon_{jc} \quad \text{for all } i, j \in g \in G \\ &k \in g \in G \\ &g = 1, 2, \dots, M_G \end{aligned}$$

$$\begin{aligned} &\text{and for all } i, j \notin G \\ &k \in G \\ &G = 1, 2, \dots, N, \end{aligned}$$

which implies that the subgroups within higher-order groups are weakly separable whereas subgroups between pairs of higher-order groups are

strongly separable. Hence, a unique ρ_{IJ} exists for each pair of intragroup subgroups whereas single ρ expresses the relationships between the elements of pairs of subgroups taken from a pair of higher-order groups. In this situation, the complete set of price elasticities can be found by estimating n income elasticities, $\frac{1}{2} \sum M_G(M_G - 1)$ intersubgroup price elasticities (where M_G is the number of subgroups in Group G),

$$\frac{1}{2} \sum_G \sum_{g \in G} n_g(n_g + 1)$$

intrasubgroup price elasticities (where N_g is the number of commodities in subgroup g), and $\frac{1}{2}N(N - 1)$ intergroup price elasticities.

The procedure may also be extended to cases of several orders of grouping within groups. There is no restriction on the number of subgroupings within each higher grouping, nor on the combination of weak and strong separability assumptions within any grouping.

The implications of other specific grouping arrangements can also be derived. The number of such arrangements is too great for each to be described in detail here. The reader can, however, try those that are of interest to him.

Data and Statistical Model

Data

A review of available U. S. time-series data indicated that seven commodity groups could be included: durables, nondurables (less food), services, dairy products, meats, cereal products, and fruits and vegetables. The years 1935 to 1962 were used; omitting the war years of 1942-1945 left a total of 24 annual observations. The income variable was defined as total expenditures and was estimated by adding reported expenditures on the seven commodity categories included. Since the seven categories of expenditure really represent rather aggregative bundles of individual commodities, the variables are themselves indices of prices and consumption.² Expenditure weights were assumed constant and estimated for nonfood groups by averaging expenditure shares for the five-year period 1957-1961. Estimates for expenditure weights for the food groups were based on 1947-1949 data and adjusted to 1957-1961 levels according to the relationship between food and nonfood expenditures during that period. The estimates are as follows: durables 0.141, nondurables 0.263, services 0.412, dairy products 0.044, meats 0.072, and fruits and vegetables 0.052.

² The data source for prices was the U. S. Department of Labor *Price Indexes for Selected Items and Groups*, 1962 and 1964. Quantities of durables, nondurables, and services were computed by dividing per capita expenditures (U. S. Department of Commerce *Business Statistics*, 1961) by U. S. Department of Labor *Consumer Price Indices*. The quantities of agricultural products were obtained from U. S. Department of Agriculture *Handbooks* 62 and 63.

Ordinal separability assumption

The seven commodities were separated into two groups—food and non-food. The assumption of weak separability between the two groups allowed a reduction in the number of parameters from 27 to 17.³

General statistical model

The following statistical model, which is linear in logarithms, was chosen primarily because it yields constant elasticities.

$$(5.1) \quad \ln X_i(t) = c_i + \sum_{j=1}^n E_{ij} \ln P_j(t) + \eta_i \ln M(t) + U_i$$

for $i = 1, 2, \dots, n$
 $j = 1, 2, \dots, n$
 $t = 1, 2, \dots, T$

where

$X_i(t)$ is per capita consumption of the i th good in the t th year,
 E_{ij} is the price elasticity of the i th good with respect to the j th price,
 $P_i(t)$ is the price of the i th good in the t th year,
 η_i is the income elasticity of the i th good, and
 $M(t)$ is per capita income in the t th year.

Using (2.8) and (3.7), one can express (5.1) as

$$(5.2) \quad \ln X_i(t) = \alpha_i - \sum_{j \in I} \beta_{ij} \ln P_j(t) + \sum_{\substack{K \\ K \neq I}} \rho_{IK} \eta_i \sum_{j \in K} \eta_j W_j \ln P_j(t) \\ + \tau_i \left[\ln M(t) - \sum_{j=1}^n \eta_j \ln P_j(t) \right] + U_i(t)$$

where I refers to the group within which the i th commodity belongs and K refers to all individual groups other than I .

There is one such equation for each commodity, but the equations are not independent and hence must be estimated simultaneously. The restrictions in equations (2.10), (2.11), (3.7), and the Engel aggregation are imposed on the system.

The restriction (2.11) may be incorporated directly into (5.2) by noting that the restriction may be rewritten, using (3.7), as

$$(5.3) \quad \beta_{ii} = - \left[\sum_{\substack{j \in I \\ j \neq i}} \beta_{ij} + \sum_{\substack{K \\ K \neq I}} \rho_{IK} \eta_i \sum_{j \in K} \eta_j W_j \right].$$

³ We are aware that the implications of the strong and weak separability assumptions do not differ for two group cases. However, the conclusions of the last section are general, and the particular empirical example tested here was selected merely for illustrative purposes.

Substituting (5.3) into (5.2) yields

$$(5.4) \quad \ln X_i(t) = \alpha_i + \sum_{\substack{j \in I \\ j \neq i}} \beta_{ij} [\ln P_j(t) - \ln P_i(t)] \\ + \sum_{\substack{K \\ K \neq I}} \rho_{IK} \eta_i \sum_{j \in K} \eta_j W_j [\ln P_j(t) - \ln P_i(t)] \\ + \eta_i \left[\ln M(t) - \sum_{j=1}^n W_j \ln P_j(t) \right] + U_i(t).$$

The other restrictions apply to the entire set of equations and hence must be imposed on the estimation procedure. Thus, (5.4) is the final statistical model from which the elasticities of demand are estimated. The error terms $U_i(t)$ were assumed to have expected values of zero, and constant variance and zero covariance over all commodities and time periods.

Equation (5.4) obviously contains nonlinear combinations of parameters, and an iterative estimation procedure was used. Writing equation (5.4) as

$$(5.5) \quad Y_i(t) = \alpha_i + \sum_{\substack{j \in I \\ j \neq i}} \beta_{ij} A_{ji}(t) + \sum_{\substack{K \\ K \neq I}} \rho_{IK} B_i(t) + \eta_i D(t) + U_i(t),$$

where

$$Y_i(t) = \ln X_i(t), \\ A_{ji}(t) = \ln P_j(t) - \ln P_i(t), \\ B_i(t) = \eta_i \sum_{\substack{j \in K \\ K \neq I}} \eta_j W_j [\ln P_j(t) - \ln P_i(t)], \text{ and} \\ D(t) = \ln M(t) - \sum_{j=1}^n W_j \ln P_j(t),$$

indicates a slight rearrangement of variables and parameters. For the first iteration, trial values of all η_i 's were used to derive the observations on B in (5.5). The dependent variable $Y(t)$ was then regressed on $A(t)$, $B(t)$, and $D(t)$. The coefficients of D from the first-round least-squares regression supplied new estimates of the η_i 's, which were in turn used to compute a second set of observations on B , etc. This procedure was continued until the estimates of η_i 's did not change appreciably from one iteration to the next. No formal test for convergency was developed.

Numerical Results

Income elasticities

Final-round estimates for income elasticities were as follows: durables 0.73, nondurables (less food) 1.00, services 1.15, dairy products 1.02, meats 0.67, cereal products 0.65, and fruits and vegetables 1.11.

Price elasticities

Final-round estimates of the β_{ij} 's and the ρ between the food and nonfood groups were as follows:

$$\begin{array}{llll} \beta_{12} = 3.65 & \beta_{45} = -0.76 & \beta_{53} = -0.11 & \rho_{FN} = 1.62 \\ \beta_{13} = -1.32 & \beta_{46} = 0.41 & \beta_{57} = -0.01 & \\ \beta_{23} = 0.72 & \beta_{47} = 0.13 & \beta_{67} = -1.40 & \end{array}$$

These estimates, along with the restrictions in (2.10), (2.11), and (3.7), were then used to derive estimates of the compensated price elasticities (Table 1), income effects (Table 2), and price elasticities (Table 3).

Table 1. Estimates of compensated price elasticities, β_{ij} 's

	Nonfood			Food			
	Durables	Non-durables	Services	Dairy products	Meats	Cereals	Fruits and vegetables
Nonfood	-2.51	3.65	-1.32	0.05	0.06	0.01	0.06
	1.96	-2.94	0.72	0.07	0.08	0.02	0.09
Food	-0.45	0.46	-0.30	0.08	0.09	0.02	0.10
	0.16	0.42	0.75	-1.11	-0.76	0.41	0.13
	0.12	0.29	0.51	-0.46	-0.34	-0.11	-0.01
	0.08	0.31	0.48	1.06	-0.47	-0.06	-1.40
	0.16	0.46	0.79	0.11	-0.01	-0.46	-1.05

Table 2. Estimates of income effects of price changes

	Nonfood			Food			
	Durables	Non-durables	Services	Dairy products	Meats	Cereals	Fruits and vegetables
Nonfood	0.10	0.19	0.30	0.33	0.05	0.01	0.04
	.14	.26	.41	.34	.07	.02	.05
	.16	.30	.47	.05	.08	.02	.06
Food	.14	.27	.42	.05	.07	.02	.05
	.09	.18	.28	.03	.05	.01	.03
	.09	.17	.27	.03	.05	.01	.03
	0.16	0.29	0.46	0.05	0.08	0.02	0.06

Evaluation of Estimates

There is little basis for comparing the estimates of this model with estimates of the single-equation partial-equilibrium type. Formal statistical tests of significance were, of course, precluded because the distribution of estimates for the nonlinear estimation procedure were unknown.

The estimates, however, are reasonable according to the authors' preconceived notions. All of the income elasticities are positive and all of the own-price elasticities negative, as expected.

Table 3. Estimates of price elasticities

	Nonfood			Food			
	Durables	Non-durables	Services	Dairy products	Meats	Cereals	Fruits and vegetables
Nonfood	-2.61	3.46	-1.62	0.02	0.01	0.00	0.02
	1.82	-3.20	0.31	0.03	0.01	0.00	0.04
Food	-0.61	0.16	-0.77	0.03	0.01	0.00	0.04
	0.02	0.15	0.33	-1.16	-0.83	0.39	0.08
	0.03	0.11	0.23	-0.49	-0.39	-0.12	-0.04
	-0.01	0.14	0.21	1.03	-0.52	-0.07	-1.43
	0.00	0.17	0.33	0.06	-0.09	-0.48	-1.11

Concluding Remarks

The technique of grouping commodities into separable groups is primarily intuitive in the absence of *a priori* knowledge of actual relationships between marginal utilities.

Although weak separability differs from strong separability only in the group placement of the goods i , j , and k , the resulting implications of weak separability for grouping criteria are intuitively more acceptable. Suppose we have a universe of commodities which can be divided into three groups: food I , clothes J , and entertainment K . Weak separability implies that the marginal rate of substitution of two goods in I , say corn and beans, is unaffected by a change in the quantity of a good in J , say neckties. Strong separability implies that the marginal rate of substitution between corn and neckties is unaffected by an increase in the quantity of movies. In the assumption of strong separability, the marginal rate of substitution between two dissimilar commodities is involved, and the plausibility of statements of this type, being less obvious intuitively, would need rather stronger empirical verification.

Or, to put it another way, the actual grouping of commodities so as not to violate the separability assumption should be much easier intuitively for weak separability. The reduction in number of parameters, however, is less impressive than with the stronger assumption.

The derivations of this paper, however, are sufficiently flexible to allow a wide choice of separability assumptions. Weak separability, strong separability, or various combinations of weak and strong separability may be assumed, depending upon the nature of the problem at hand. The possibility of testing the sensitivity of the elasticity estimates to various assumptions about the separable nature of the utility function also exists.

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Discussion: Estimation of Demand for Food and Other Products Assuming Ordinally Separable Utility

MILTON C. HALLBERG

One of the inescapable facts of the social scientist's life is that the problems he encounters are extremely complex and difficult to unravel. This is true if he is attempting to dissect an unwieldy farm bargaining association, or to uncover the system of relationships underlying the web of consumer behavior. As a result, any attempt to ease the burdens of dissection via realistic and simplifying assumptions or techniques of analysis tends to be regarded as commendable.

Techniques of demand analysis have graduated from the more pedestrian ones of Moore's day to the more complex ones of today, thereby making the demand analyst's job more difficult. Boutwell and Simmons, following the work of Strotz [5] on "utility tree" analysis and more recently of Pearce [5] on separable utility and Barten [1] on additive preferences, propose a move to counteract this trend—making the demand analyst's task easier by incorporating simplifying assumptions into classical demand theory.

In the paper under discussion, the authors' objectives are (1) to reduce the number of parameters to be estimated in a complete demand model and (2) to suggest a technique for estimating these parameters from time-series data. The first objective can be accomplished, they argue, by assuming that the ratios of marginal utilities between two selected commodities are independent of changes in the level of consumption of a third—that is, employing the neutral-want assumption of Pearce [5]. This approach is in contrast to Frisch's assumption [3] of want-independence, which presupposes that the marginal utility of a certain commodity is independent of changes in the level of consumption of a second.

The relative merits and demerits of these two propositions have been adequately treated in the literature cited. Suffice it to say that, if the

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proper combination of commodities is involved, either of these two propositions will probably be acceptable as reasonable approximations to actual consumer behavior. Thus, the only argument appears to be that of cardinal utility (implied by the want-independence proposition) versus ordinal utility (implied by the neutral-want proposition)¹—an argument which we do not wish to pursue here.

Since the assumptions, if judiciously applied, appear to be sound, the next question one must investigate is, Does the Boutwell-Simmons procedure produce acceptable results and does it possess clear-cut advantages over some alternative?

It appears to me that the case for the Boutwell-Simmons approach (or more generally, the separable utility approach) has, either directly or by implication, been overstated. In the first place, it is questionable whether, in many attempts to construct a matrix of demand elasticities, the number of parameters to be estimated will be reduced by the Boutwell-Simmons approach by a sizable enough margin to be useful.

This, of course, will depend upon the number of separable groups and on the number of commodities in each group. But, for illustrative purposes, consider the model developed by Brandow [2] in which a complete matrix of demand elasticities was estimated for 24 foods and one nonfood category. Had Brandow used the Boutwell-Simmons approach assuming food and nonfood consumption to be weakly separable, he would have reduced the number of parameters to be estimated from 324 to 301—still a sizable number of parameters to be estimated from time-series data for a highly aggregated system.

Secondly, the associated problems involved in estimating the parameters from either time-series or cross-sectional data using the Boutwell-Simmons approach must be considered. This approach, at best, involves some sort of nonlinear estimating scheme if the parameters are estimable at all. Thus, additional computational burden and errors of approximation are introduced. Furthermore, "for reasons that are largely pragmatic" [1, p. 8], the researcher adopting the Boutwell-Simmons approach is somewhat restricted in his choice of the functional form of the demand equation. Thus, he probably would be reluctant to experiment with functional forms such as those specified by Waugh [7, p. 17], for instance, in which demand elasticities are allowed to vary over the course of time or with changes in other variables.

All this and the simultaneous nature of supply and demand relations has not yet been given passing notice!

¹ Indeed, even this might be a fruitless argument since, as Pearce [5] points out, under certain conditions the neutral-want assumption and the want-independence assumption lead to the same conclusions with respect to the more important results obtained by Frisch.

Turning to the numerical results of the paper under discussion, we are left with a feeling of uneasiness due to an absence of any criteria with which to make an appraisal. This is due to the authors' use of a nonlinear estimation technique having questionable virtues. No estimates of reliability of the elasticities are available, no evidence of the optimality of the estimation technique employed is provided, and indeed the exact nature of the estimation scheme is unclear from the discussion. Had the authors used a nonlinear estimating technique such as that suggested by Hartley [4] on an equation-by-equation basis, they would have obtained inconsistent estimates of those parameters appearing in two or more equations of the system. As far as I know, there is no easy solution to this problem without recourse to a lengthy iterative process such as that in the article by Barten [1].

Although the estimated own-price elasticities appear to have intuitively acceptable signs, some of the estimated cross elasticities do not. In addition, the magnitude of some of the cross elasticities appears to be unacceptable—consider E_{64} and E_{67} , for instance. Even though the numerical results derived by Boutwell and Simmons were only intended to serve the purposes of an empirical example, it would have been revealing to compare the estimates derived (using an appropriate estimation scheme) with those from a procedure which did not assume separability.

Although I believe there are serious pragmatic limitations to the Boutwell-Simmons approach to demand analysis, the authors are to be complimented for outlining a refreshingly new method—originally devised by Pearce [5]—of deriving the famous Slutsky equation (equation 2.8). As they demonstrate, this development proved useful in incorporating the neutral-want assumption. It also provides an interesting framework for understanding some of the relations introduced by other writers.

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A Framework for Policy in the Feed-Livestock Economy*

RICHARD L. FELTNER

MANY farm policy discussions have ignored the fact that programs which affect prices or production of feed grains also have important direct and indirect effects on all segments of the livestock industry utilizing these grains. Several empirical studies in recent years have examined certain relationships between the feed economy and selected segments of the livestock economy.¹

In the present study, a framework and mechanism were developed for analyzing interrelationships between the aggregate feed and livestock economies.² The entire feed-livestock economy is large, complex, and highly interrelated. An ideal model might be a complete Walrasian framework which would include all demand, supply, and spatial components of the feed-livestock industry. A willingness to settle for something slightly less grandiose led to a model designed to estimate only some of the most important demand and supply relationships. The relationships were then used to examine probable aggregate effects of a policy which would maintain a substantial reduction in the U. S. production and consumption of feed grains.

Hildreth and Jarrett [5] provided one of the earliest attempts to bring together in one model the entire feed-livestock sector of the agricultural economy. Their work was also somewhat of a pioneering effort in the application of econometrics. The model developed in this study bears resemblance to the model developed by Hildreth and Jarrett. An integral part of this study, in fact, involved bringing the Hildreth-Jarrett model up to date. Time is not spent here on the Hildreth-Jarrett model, except occasionally to point out similarities or differences between that model and the one developed in this study.

Model Specification

The model consists of five equations relating variables considered to be important in the demand-supply-price structure of the aggregate feed-livestock economy.

* Michigan Agr. Exp. Sta. J. Art. 4259.

¹ For example, see Langmeier and Thompson [7], Egbert and Reutlinger [2], and Unger [8].

² For a more detailed report, especially with regard to data sources and construction of variables, see Feltner [3].

- (1) $Y_4 = f(Y_5, z_2, Z_3, Z_6)$ (demand for inventory)
- (2) $Y_2 = f(Y_5, Z_1, z_2, Z_3, Z_4)$ (demand for feed grains)
- (3) $Y_3 = f(Y_5, Z_1, z_2, Z_3, Z_4)$ (demand for protein feed)
- (4) $Y_1 = f(Y_5, Y_4, Z_1, z_2, Z_3, Z_4)$ (supply of livestock products)
- (5) $Y_1' = f(Y_5, z_2, Z_5', Z_7)$ (demand for livestock products)

where

- Y_1 is the log of total sales of livestock and livestock products,
- Y_1' is the log of per capita sales of livestock and livestock products,
- Y_5 is the log of the price index of livestock and livestock products,
- Y_2 is the log of quantity of feed grains fed,
- Y_3 is the log of quantity of protein feed fed,
- Y_4 is the change in livestock inventory ($\log z_{1,t+1} - \log z_{1t}$),
- Z_1 is the log of the January 1 livestock inventory,
- z_2 is the time (as a natural number),
- Z_5' is the log of per capita disposable income,
- Z_7 is the log of the index of wholesale prices of commodities, excluding farm products,
- Z_3 is the log of feed grains price,
- Z_4 is the log of protein feed price, and
- Z_6 is the log of the farm mortgage interest rate.

Demand for feed grains and protein feed

For estimation purposes, the prices of feed grains and protein feed were both treated as predetermined. A theoretically more complete model might include relations for the supply of feed grains and the supply of protein feed. If this were done, feed grain and protein feed prices would both be treated as endogenous variables. However, this was not done for two reasons. First, specifying a meaningful supply relationship for either feed grains or protein feed is a formidable task in itself. Second, government programs which have existed over the past several years have probably acted upon feed grain prices in a manner not unlike administered prices. Treating prices of feed grains and protein feed as predetermined implies perfectly elastic supply curves for both.

Supply of livestock and livestock products

The quantity of livestock and livestock products *produced* and the quantity *sold* in a given time period are not necessarily equal. This is so because of changes in livestock inventories which may occur. At the beginning of a time period (or at any given moment of time) inventories are fixed at some level. However, during a time interval, t , producers must decide how much production should be sold and how much kept as inventory at the

beginning of the next time period ($t+1$). Since the supply function needs to be expressed in terms of quantity sold, a problem exists in bridging the gap between quantity of livestock and livestock products produced and quantity sold.

Changes in inventory were made an integral part of the model in developing the supply relation. We may consider (but not specify explicitly) a production function where quantity of livestock and livestock products produced is a function of quantities of feed grains and protein feed fed, the January 1 inventory, and time. The general form of the supply function which is derivable from this implicit production function is

$$(6) \quad y_{6t} = f(y_{5t}, z_{3t}, z_{4t}, z_{2t}, z_{1t}),$$

where

y_{6t} is the quantity of livestock and livestock products *produced*,

y_{5t} is the price of livestock and livestock products,

z_{1t} is the January 1 inventory of livestock on farms,

z_{2t} is time,

z_{3t} is the price of feed grains, and

z_{4t} is the price of protein feed.

This supply function, however, is in terms of quantity produced. As discussed above, the quantity of livestock and livestock products produced and the quantity sold in a given time period are not necessarily equal, because of changes in inventory. This leads to an expression for an inventory "identity":

$$(7) \quad \frac{z_{1,t+1}}{z_{1t}} = \alpha_0 \left(\frac{y_{6t}}{y_{1t}} \right)^{\alpha_1},$$

where y_{1t} is the quantity of livestock sold and the other variables are as defined above. That is, the ratio of inventory on January 1 of time $t+1$ to inventory on January 1 of time t is a function of the ratio of production to sales in time t . Because of problems of aggregating heterogeneous products, the relationship is not exact and hence is stated in functional form. Equation (7) is written in terms of ratios, and the parameter α_1 is written as an exponent, because the supply function finally derived (10) is estimated using a form linear in the logarithms of the variables. To facilitate exposition, we specify a particular parametric form for the supply equation (6):

$$(8) \quad y_{6t} = y_{5t}^{\beta_1} z_{3t}^{\beta_2} z_{4t}^{\beta_3} z_{1t}^{\beta_4}.$$

Solving (7) for y_{6t} yields

$$(9) \quad y_{6t} = \frac{y_{1t}}{\alpha_0} \left(\frac{z_{1,t+1}}{z_{1t}} \right)^{1/\alpha_1}.$$

Substituting (9) into (8) yields the final supply relation in terms of quantity sold:

$$(10) \quad y_{1t} = \alpha_0 \beta_5 t^{\beta_1} z_{3t}^{\beta_2} z_{4t}^{\beta_3} z_{1t}^{\beta_4} \left(\frac{z_{1,t+1}}{z_{1t}} \right)^{-1/\alpha_1}.$$

That is, the quantity of livestock and livestock products sold in time t is a function of the price of livestock, the price of feed grains, the price of protein feed, the January 1 livestock inventory in time t , and the change in livestock inventory from the beginning of time t to the beginning of time $t+1$.

Demand for inventory

Explicit accounting of changes in inventory is an important feature of the model. The decision to hold increased inventories (reducing current sales) represents, in a very real sense, an investment in a capital good. The interest rate was included to approximate a cost of holding additional inventories. In the absence of any more specifically applicable measure, the farm mortgage interest rate was used.

Several forms of the inventory demand relation were tried, with the price of protein feed and an "expected product price" variable included.³

³ A strong positive relationship between changes in inventory and expected product price in a future time period was hypothesized. At the same time, it was reasoned that a negative relationship exists between current product price and change in inventory. The inventory demand relation was written as

$$(11) \quad Y_{4t} + \gamma_2 z_{2t} + \gamma_3 z_{3t} + \gamma_6 Z_{6t} + \beta_5 Y_{5t} + \beta_5^* Y_{5,t+\theta},$$

where

Y_{4t} is the change in inventory, $\log \left(\frac{z_{1,t+1}}{z_{1t}} \right)$,

z_2 is time,

Z_{3t} is the log of the feed grain price index,

Z_{6t} is the log of the farm mortgage interest rate,

Y_{5t} is the log of the price index of livestock and livestock products, and

$Y_{5,t+\theta}$ is the log of the expected price index of livestock and livestock products.

As a first approximation for the price expectation variable, the following partial distributed lag form was hypothesized:

$$(12) \quad Y_{5,t+\theta} = \gamma_7 Y_{5t} + \gamma_0(1 - \gamma_0) Y_{5,t-1} + \gamma_0(1 - \gamma_0)^2 Y_{5,t-2}.$$

Substituting (12) into (11) yields

$$(13) \quad Y_{4t} = \gamma_2 z_{2t} + \gamma_3 z_{3t} + \gamma_6 Z_{6t} + (\beta_5 + \beta_5^* \gamma_0) Y_{5t} \\ + \beta_5^* \gamma_0 (1 - \gamma_0) Y_{5,t-1} + \beta_5^* \gamma_0 (1 - \gamma_0)^2 Y_{5,t-2}.$$

Least-squares estimates of the parameters in (13) were obtained. $(\beta_5 + \beta_5^* \gamma_0)$, $\beta_5^* \gamma_0 (1 - \gamma_0)$ and $\beta_5^* \gamma_0 (1 - \gamma_0)^2$ were then solved for β_5 and β_5^* in (11) and γ_0 in (12). The resulting estimates of β_5 and β_5^* were both positive.

In a second approximation, the expected product price variable was written as

The coefficient of the price of protein feed was not statistically significant in any case, and it was omitted from the final form. The simple correlation coefficient between protein feed price and feed grains price was 0.90.

Demand for livestock and livestock products

To account explicitly for population changes over the course of time, the demand for livestock and livestock products relation is stated in per capita terms. Per capita consumption of livestock and livestock products is taken to depend on the price of livestock, per capita disposable income, the price of nonfarm products,⁴ and time. Lagged consumption is frequently included as an additional explanatory variable in demand relations for various food products. However, early experimentation with lagged consumption in this relation yielded a nonsignificant coefficient, and it was omitted in the final specification.

Estimation

Three methods of estimation—least squares, two-stage least squares, and limited-information single equation—were applied to the equations in the model. Annual time-series data were used. Estimates of coefficients for two time periods, 1920–1949 and 1920–1962, were obtained. The shorter period was used primarily to serve as a bench mark for comparing the model with the earlier work by Hildreth and Jarrett. For all three estimating procedures each equation was estimated as a form linear to the logarithms of the variables. Time, however, entered in each equation as a natural number. Coefficients obtained for the five equations using the three methods of estimation are presented in the Appendix.

Several alternative forms of some of the equations were estimated. The coefficients of protein feed price and quantity caused more concern than any of the other variables in the model. After noting the high (0.90) simple correlation between protein feed price and feed grain price, equation (2) was re-estimated omitting the protein feed price variable and equation (3) was re-estimated omitting the feed grains price variable. In both cases the

$$(14) \quad Y_{5,t+6}^* = \gamma_0 Y_{5t} + \gamma_0(1 - \gamma_0)^2 Y_{5,t-2} + \gamma_0(1 - \gamma_0)^4 Y_{5,t-4}.$$

Least-squares estimation again led to positive estimates of β_5 and β_5^* .

With both forms of the expected price variable, the estimated coefficients of the lagged price variables in (13) were not significant. Autocorrelation between these variables made it impossible to separate the dual roles of current product price as (a) an indicator of the cost of holding inventory (foregoing income from current sales) and (b) an indicator of the expected product price in future time periods. The second apparently far overshadows the first.

⁴ Ideally, it would be desirable to use a price index here which includes all consumer products except livestock and livestock products. The index used excludes fruits and vegetables, which, while they are not direct substitutes for livestock products, do compete with livestock products for the consumer's dollar. However, the index used was felt to be the best available.

coefficients of the remaining variables were virtually unchanged, and more unfavorable Durbin-Watson statistics were obtained.

The Durbin-Watson statistics computed for equation (3) indicated a significant amount of positive autocorrelation. The Hildreth-Lu procedure [6] was used to estimate the least-squares parameters in the equation by eliminating autocorrelation. An autocorrelation coefficient of approximately 0.75 was indicated. No attempt was made to remove the autocorrelation in the framework of either two-stage least-squares or limited-information estimation.

Estimates of the elasticity of demand for feed grains were obtained (Table 1) by solving for the coefficient of feed grain price in the reduced form of the limited-information and two-stage least-squares estimates. Also, an elasticity estimate was obtained by regressing Y_2 directly upon the Z variables appearing in the Y_2 equation of the reduced form. For both time periods, the direct least-squares estimate of elasticity was smaller than the estimates obtained from the other two methods. For all three methods, the 1920-1962 estimates were enough larger than the 1920-1949 estimates to indicate that an increase in the elasticity of demand for feed grains probably occurred in recent years.

Table 1. Estimates of the elasticity of demand for feed grains

Method of estimation	Time period	
	1920-1949	1920-1962
Limited information reduced form	-0.375	-0.617
Two-stage least squares reduced form	-0.396	-0.514
Direct least squares on reduced form exogenous variables	-0.291	-0.326

Application to Feed Grain Policy

One of the stated objectives of the 1961 Emergency Feed Grain Program was to reduce the annual production of feed grains from the 1960 level of 156 million tons to approximately 140 million tons. The 1920-1962 LISE estimates of the model were used to analyze some of the probable income effects of such a reduction in feed grain production. Because of an interest in tying the analysis to the time period in which the Feed Grain Program originated, 1960 was used as a base year. Feed grain production in the 1961-1966 period has, in fact, averaged 147.4 million tons, with production of over 157 million tons in 1965 and 1966.

Assumptions

Four assumptions were made in the analysis: (1) that, given the 1960 levels of all the exogenous variables in the model except feed grain price,

a program is adopted that would actually reduce feed grain production from 156 million tons to 140 million tons (a 10.26 percent reduction) for several consecutive years; (2) that the quantity of feed grains fed to livestock would decline by the same percentage amount;⁵ (3) that government stocks of feed grains would not be made available to livestock producers; and (4) that feed grain prices would be determined solely by the actions of a free market (no government payments to feed grain producers).

Procedure

The reduced form of equations (1), (2), (4), and (5) was obtained.⁶ When the parameters of the model were originally estimated, the supply of feed grains was treated as perfectly elastic. The assumption that the quantity of feed grains is fixed at a certain level implies that the supply of feed grains is perfectly inelastic at that level. Consistent with this, the quantity of feed grains fed was treated as fixed and the price of feed grains was treated as an endogenous variable when the reduced form was obtained. Thus, in the reduced form, change in inventory, price of livestock, quantity of livestock sold, and feed grain price were each expressed as functions of the exogenous variables in the system.

The procedure was then as follows: (1) The assumed reduced quantity of feed grains fed and the actual 1960 values of the exogenous variables were used to predict values of the four endogenous variables. (2) The actual 1960 January 1 inventory was adjusted downward by the amount implied from the predicted change in inventory from Step 1. (3) Step 1 was then repeated, with the exception that the new value of January 1 inventory from Step 2 was used rather than the 1960 actual value. These estimates are presented under "Period 2" in Table 6. The process was then repeated for successive periods. The dynamic nature of the model is apparent from the fact that inventory changes during each time period directly influence the potential sales of livestock in the following period.

Changes in total revenue, total costs, and net revenue (assuming feed grains as the only cost) for the aggregate of livestock producers were computed, using the predicted values of the four endogenous variables for each time period (Table 2). Changes in total revenue to feed grain producers in each period were similarly computed (Table 2).

Results using estimated coefficients

The first-period effect of a 10.26 percent reduction in feed grain production would be to increase feed grain price to about 19 percent above what it would have been without the reduction, and to increase the total revenue to feed grain producers by almost 7 percent. Livestock sales would increase

⁵ This allows the same percentage of feed grain production to flow into nonfeed uses.

⁶ Limited-information estimates for the 1920-1962 period were used.

Table 2. Projected effects from 1960 of a feed grain program that would reduce feed grain production from 156 million tons to 140 million tons

Item	1960 actual value	Percent of 1960 actual value ^a							
		Period 1	Period 2	Period 3	Period 4	Period 5	Period 6	Period 7	Period 8
Feed grain price	\$23.74 ^b	118.9 (120.6)	115.0 (110.8)	112.9 (106.6)	111.9 (104.6)	111.2 (103.7)	110.8 (103.2)	110.5 (107.8)	110.4 (105.1)
Livestock price index	1,5416 million \$	98.6 (99.5)	103.5 (97.9)	106.3 (97.1)	107.6 (96.8)	108.6 (96.6)	109.2 (96.6)	109.5 (97.3)	109.7 (96.8)
January 1 livestock inventory	6,332 ^c	95.9 (95.8)	93.7 (93.9)	92.7 (93.0)	91.9 (92.6)	91.5 (92.4)	91.2 (94.4)	19.1 (93.2)	91.0 (92.7)
Total livestock sales	11,154 ^d	100.1 (100.3)	99.8 (99.0)	99.7 (98.4)	99.6 (98.1)	99.6 (98.0)	99.6 (97.9)	99.6 (99.3)	99.5 (98.2)
Total revenue, livestock producers	17,105	98.7 (99.5)	103.3 (96.9)	105.0 (95.6)	107.9 (94.9)	108.9 (94.6)	108.7 (94.5)	109.0 (96.0)	109.9 (95.1)
Total costs, livestock producers	4,755 ^e	106.7 (108.2)	103.3 (99.4)	101.3 (95.7)	100.4 (93.9)	99.8 (93.0)	99.4 (92.6)	99.3 (96.7)	99.1 (94.4)
Net revenue, livestock producers	12,441 ^e	95.6 (96.7)	103.3 (96.0)	107.7 (95.5)	109.8 (95.4)	111.3 (95.2)	112.3 (95.2)	112.8 (95.8)	113.1 (95.4)
Total revenue, feed grain producers	5,795	106.7 (108.2)	103.2 (99.4)	101.3 (95.7)	100.4 (93.9)	99.8 (93.0)	99.4 (92.7)	99.2 (96.7)	99.1 (94.4)

^a Percentages not in parentheses indicate projections based on reduced form of model as originally estimated. Percentages in parentheses indicate projections based on reduced form of model with elasticity of demand for livestock equal to -0.8.

^b Dollars per 1,000 pounds of TDN.

^c Actual inventory evaluated in million dollars of estimated potential production.

^d Pounds of livestock sold valued at 1920-1949 average prices.

^e Feed grains are the only cost considered.

and livestock inventories would be reduced during the first period in response to the higher feed grain price. In the second period, still assuming the same reduced levels of feed grain production and consumption, feed grain price and total revenue to feed grain producers would decline from the Period 1 levels. Livestock sales would decline slightly, but net revenue to livestock producers would rise to about $3\frac{1}{2}$ percent above the 1960 actual level. From Period 2 to Period 3, a general damping trend starts in each of the endogenous variables and the calculated revenues and continues throughout the remaining periods for which estimates were obtained.

It appears that a government program that would effectively reduce the quantity of feed grains produced and fed by about 10 percent would, after the initial period, increase both total and net revenue to livestock producers. Feed grain producers could expect increased total revenues for some time beyond the initial reduction period. However, total revenue would gradually decline to a level at, or slightly below, that existing at the time of the reduction.

Results using adjusted coefficients

These results are consistent, given the assumptions made and the parameter estimates used. However, intuitively, one is made extremely uneasy by an analysis which indicates that livestock producers could be made so much better off by a program which increases feed grain costs. One of the more obvious possible causes of such a result was the fact that an elasticity of demand for livestock products of only -0.048 was estimated and, hence, was used in the policy analysis. To examine partially the consequences of this low elasticity estimate, an elasticity of -0.8 was substituted, and the reduced form of the equations was again obtained.⁷ The policy analysis yielded very different results. (These are indicated by the figures in parentheses in Table 2.)

Throughout all periods, feed grain price remained above the pre-reduction level, though by a smaller margin than in the previous analysis. The livestock price index was lower in all periods than the pre-reduction level, while livestock sales declined slightly. The net result was a *reduction* in net revenue to livestock producers and a *reduction* in total revenue accruing to feed grain producers. No direct inferences can be made from the analysis about net revenue to feed grain producers. However, even given that reduced production would result in reduced cost, it is doubtful that net revenues would be above the pre-reduction level.⁸

⁷ While there are no strictly comparable estimates of farm-level price elasticity of demand for "all livestock products," the work by Brandow [1] would indicate that the -0.8 figure probably represents a closer approximation than does the -0.048 figure.

⁸ In any case, a complete analysis of benefits, including the consumer, treated in the Marshallian framework, would, of course, imply a net loss to society as a whole.

Summary

The model provides insight into some of the aggregate relationships in the feed-livestock economy and also provides a useful foundation for comparing alternative statistical estimation techniques. While the model performed adequately in terms of predicting within the time span of the data, certain cautions must be raised when the model is used to explore beyond the range of the data. In the feed grain policy analysis, for example, conclusions about the net effects of a particular program on feed grain and livestock producers were shown to differ drastically, depending upon the value assumed for a particular coefficient.

Some of the limitations of this approach are obvious, while others are more subtle. Any analysis which treats all of the many livestock components simply as "livestock" cannot yield answers to questions about specific segments of the industry such as hogs, cattle, or broilers. Further, adequate account cannot be taken of the different production cycles of these various commodities. Because of the level of aggregation and the method used in constructing variables, it is not possible to reflect adequately one of the more important effects of a reduced level of feed grain production. In the analysis as it now stands, it is impossible to isolate from overall changes in livestock producers' net income that part of the income change which results from reductions or increases in inventory. That is, cash flows can be determined, but changes in stock (inventory) value are not adequately reflected.

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(Appendix Table appears on the following pages)

Appendix Table. Estimates of coefficients for using three methods of estimation, 1920-1962^a

Equation (1) Demand for inventory	1920-1962		
	LS	TSLS	LISE
Regression coefficients			
Price of livestock	0.211 (0.029)	0.222 (0.038)	0.229
Time	-0.0003 (0.0002)	-0.0008 (0.0003)	-0.0009
Price of feed grains	-0.210 (0.025)	-0.218 (0.032)	-0.223
Interest rate	-0.160 (0.044)	-0.162 (0.050)	-0.164
Constant term	0.399	0.412	0.420
R ²	0.667	0.575	
Durbin-Watson statistic	1.92	2.09	
Equation (2) Demand for feed grains	1920-1962		
	LS	TSLS	LISE
Regression coefficients			
Price of livestock	0.379 (0.113)	0.541 (0.177)	0.858
January 1 inventory	1.361 (0.177)	1.382 (0.182)	1.424
Time	0.003 (0.0008)	0.0026 (0.001)	0.001
Price of feed grains	-0.461 (0.072)	0.493 (0.078)	-0.556
Price of protein feed	0.303 (0.140)	0.158 (0.187)	-0.125
Constant term	-5.164	-5.075	-4.901
R ²	0.912	0.909	
Durbin-Watson statistic	1.42	1.46	
Equation (3) Demand for protein feed	1920-1962		
	LS	TSLS	LISE
Regression coefficients			
Price of livestock	0.413 (0.098)	0.672 (0.146)	1.070
January 1 inventory	0.592 (0.154)	0.626 (0.150)	0.678
Time	0.011 (0.0006)	0.009 (0.0008)	0.008
Price of feed grains	-0.082 (0.063)	-0.133 (0.065)	-0.212
Price of protein feed	-0.177 (0.122)	-0.408 (0.154)	-0.763
Constant term	1.459	1.600	1.734
R ²	0.985	0.986	
Durbin-Watson statistic	0.69	0.56	

^a Numbers in parentheses are standard deviations.

Appendix Table (*Continued*).

Equation (4) Supply of livestock products	1920-1962		
	LS	TOLS	LISE
Regression coefficients			
Price of livestock	0.111 (0.102)	0.685 (0.154)	0.887
Change in inventory	-0.946 (0.276)	-2.144 (0.382)	-2.563
January 1 inventory	0.494 (0.128)	0.410 (0.114)	0.381
Time	0.006 (0.0005)	0.004 (0.0007)	0.004
Price of feed grains	-0.199 (0.069)	-0.456 (0.083)	-0.547
Price of protein feed	0.170 (0.101)	-0.184 (0.122)	0.309
Constant term	4.900	6.674	7.230
R^2	0.961	0.971	
Durbin-Watson statistic	1.25	1.67	
Equation (5) ^b Demand for livestock	1920-1962		
	LS	TOLS	LISE
Regression coefficients			
Price of livestock	-0.105 (0.041)	-0.073 (0.048)	-0.049
Per capita disposable income	0.218 (0.071)	0.192 (0.077)	0.172
Price index, excluding farm products	-0.036 (0.072)	-0.043 (0.076)	-0.048
Time	-0.0006 (0.0005)	-0.0004 (0.0006)	-0.0002
Constant term	1.214	1.302	1.515
R^2	0.707	0.672	
Durbin-Watson statistic	1.78	1.87	

^b The years 1943-1946 were omitted when estimating equation (5).

Discussion: A Framework for Policy in the Feed-Livestock Economy

CLIFFORD HILDRETH

To try to evaluate very many aspects of a study of this complexity in such a short session would be foolish even if I had been able to give it the extended attention necessary to make a thorough evaluation. Accordingly,

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I shall briefly note several respects in which this study seems well conducted and then talk about possible future developments which I hope will gradually increase the usefulness of work of this kind.

The fact that the study exploits previous work well is certainly favorable. If we are ever to develop econometric models of sufficient reliability that we are justified in taking the results seriously even when they force revisions in our previous notions, we shall have to learn from each other's experiences. The specification uncertainties that exist in representing any important sector of the economy in a tractable model are just too great and numerous to be resolved by a single investigator in a single study.

The fact that possible uses of the results are considered along with development of the model and interpretation of the results is also a favorable aspect of the study. Prospective uses may sometimes indicate that particular parameters or properties of the estimated structure are of critical importance and enable the investigator to analyze the critical features as thoroughly as possible. Sometimes this may best be done by simplifying parts of the model that are believed to be only peripherally related to the critical properties.

Turning now to some suggestions for further work, it would be desirable, as was suggested in the presentation, to estimate parameters of this model by full information maximum likelihood, and three-stage least-squares procedures, as well as those which were used. It would also be interesting to work out a simultaneous equation estimation procedure that would allow for autocorrelated disturbances in the equations for which these are strongly indicated.

I am inclined to regard each instance in which a time variable plays an important role in an empirical equation as an unanswered challenge. Unless the unobserved factors for which time is a proxy and their impacts on the various endogenous variables are pretty well understood, the investigator is not in a position to conjecture whether the apparent influence of time will persist, disappear, or reverse itself. Possible explanations should be formulated and evidence to help choose among alternative explanations examined as quickly as possible. Also, if time is an inaccurate proxy, biases in the estimated coefficients of observed independent variables may be introduced.

Even when our models for various economic sectors have been vastly improved and more thoroughly tested, it may often be the case that the usual market data we use in our analyses just doesn't contain enough information about some of the parameters that are important for economic decisions. This is to say that, even if we reach a point where we feel confident that specification biases and errors are small, errors in estimated parameters due to sampling fluctuations may still make the estimates of small use. This places a premium on developing effective procedures for com-

binning information contained in the data ordinarily available in econometric studies with information from other sources.

One possibility is illustrated in the Boutwell paper presented earlier. By developing more specific theories of the phenomena being studied, one can sometimes reduce the effective number of parameters to be estimated from market data and increase the accuracy of estimation of remaining parameters.

Another suggestion was contained in an earlier paper of mine[1]. It was indicated that relations such as supply functions for outputs and demand functions for inputs of an industry could be obtained by parametric programming of a reasonable number of representative firms and appropriately aggregating their individual supply and demand relations.

A still more effective way to bring various pieces of information to bear on policy decisions is to formulate policy problems as problems of decision making under uncertainty. It is not entirely clear how this can best be done, but I believe we are ready to make some useful starts. My own inclination is to employ a Bayesian framework, which would summarize information that does not lend itself readily to formal statistical analysis in a prior distribution of unknown parameters. This prior information would then be combined with the sample information to obtain an appropriate posterior distribution. In this approach, one must also specify a utility function, a space of possible decisions [2], and relations saying how outcomes in which the decision maker is interested depend on the decision taken and the true values of unknown parameters. These are difficult concepts to formulate, but even crude beginnings would clarify some aspects of practical problems. In some cases, a crude beginning might consist of just listing the main variables that enter particular relations. For example, in applications of the livestock model just discussed, the utility function should include at least farm income, consumer prices, effects on growth and stability of the U.S. and other economies, and world food supply. Keeping all of these variables in view in practical policy discussions would itself eliminate a few of the confusions that sometimes arise.

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A Test of the Hypothesis of Economic Rationality in a Less-developed Economy: An Abstract

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A SUBSTANTIAL body of economic theory involves the hypothesis of economic rationality (that is, the hypothesis which assumes that firms have knowledge of their production, cost, and return functions) and implies certain behavior relating to the profit-maximization conditions. The purpose of this paper is to make the hypothesis of profit-maximization directly testable from easily available data and to test it in relation to a group of 430 subsistence farms in an underdeveloped region of Greece.

The Methods and the Results

It is well known that under certain limiting assumptions:

- a) if all firms had the same production function (that is, the same technical knowledge and identical fixed factors),
- b) if all firms faced the same prices in the product and factor markets, and
- c) if all firms maximized profits perfectly and instantaneously, then all firms would have the same quantities of inputs and outputs.

The data we utilize for testing the rationality hypothesis are the observable *differences* in input mixes for firms that produce relatively homogeneous outputs. Since we make *none* of the assumptions *a* to *c* above, but instead explicitly assume them not to be fulfilled, we are able to explain, and indeed to measure quantitatively, the extent to which each of those assumptions is violated.

Central to our approach is the assumption that firms do *not* have the same production functions. The Cobb-Douglas production function that we posit has constant input coefficients. Yet we explicitly allow for variations from farm to farm in such factors as efficiency, technical knowledge, and volume and quality of fixed factors such as land and entrepreneurship. These variations are incorporated in the constant term in the production function, which by hypothesis varies from farm to farm.

We do *not* assume that firms face the same prices in the product and factor markets; nor do we use prices as data in our model at all. Instead, we posit a constant elasticity demand function for output and constant elasticity supply functions for inputs. Therefore, we explicitly allow for imperfect markets and thus for variations in product and factor prices from farm to farm, and indeed measure the elasticities of supply prices of inputs from our data on the input-output mix.

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Nor is perfect and instantaneous profit maximization an assumption that we make. It is, instead, a hypothesis that we test. Our model explicitly allows for deviations from profit maximization and is so formulated as to enable us to construct an index of the degree to which farms, on the average, depart from profit maximization.

The test of our model reveals that in the context of peasant Greek agriculture the evidence supports the profit-maximization hypothesis—albeit not perfect profit maximization. More specifically, we show the following:

1. With regard to assumption *c*, approximately two-thirds of the total variance in the inputs of capital and labor can be explained by variations in the profit-maximizing component of these inputs, even under strong assumptions which tend to bias this ratio downwards.

2. These variations in the profit-maximizing component of the inputs are, in turn, explained by variations in the production function and prices of outputs and inputs between firms. This refers to assumption *b*.

3. As regards prices of inputs and assumption *a*, we find that the observed relationship between the inputs and the output is consistent with the hypothesis of profit maximization in somewhat imperfect factor markets. Our model yields estimates of the elasticity of supply of capital and labor of -9 and $+5$, respectively. Both values accord well with *a priori* notions for Greek agriculture.

The Model

The deterministic model develops from a system of four equations which involve the Cobb–Douglas production function in two inputs and one output, with constant elasticities across firms but variable efficiency parameter between firms; the supply equations for capital and labor, with constant supply elasticities; and the demand equation for output, with constant demand elasticity. By using the system of these four equations to derive the partial profit-maximization conditions, we obtain

$$(1) \quad \log K_i = \frac{g}{\left(1 + \frac{1}{\eta}\right)} \log A_i + \text{constant},$$

$$(2) \quad \log L_i = \frac{g}{\left(1 + \frac{1}{\epsilon}\right)} \log A_i + \text{constant},$$

$$(3) \quad \log V_i = g \log A_i + \text{constant},$$

where, K , L , and V are capital, labor, and output, respectively; A_i is the efficiency parameter in the production function (by hypothesis exogenous and variable between firms in our model); η and ϵ are the elasticity of

supply of capital and labor; and g is a constant that involves the elasticities of the production function and the elasticities of supply of the two inputs. The crucial feature of our model is, therefore, that the logs of the profit-maximizing inputs and output are expressed as increasing linear functions of the log of the individual firm's efficiency parameter, A_i , which is an exogenous variable. Equations (1) to (3) immediately lead to expressions that involve $\log V_i$ as a function of $\log K_i$, $\log V_i$ as a function of $\log L_i$, and $\log K_i$ as a function of $\log L_i$, with the slope coefficients being $[1 + 1/\eta]$, $[1 + 1/\varepsilon]$, and $[1 + 1/\varepsilon]/[1 + 1/\eta]$, respectively.

The stochastic formulation of the model involves the errors-in-variables approach. We assume that the observed quantities of inputs and outputs each contain a systematic profit-maximizing component, the unobserved variables K_i , L_i , and V_i , plus a random term representing deviations from profit maximization. In this context, if the variance of the observed inputs and output could be explained entirely by the variation in their systematic components, this would be evidence of perfect economic rationality. On the other hand, if the variation in the observed variables cannot be explained at all by their systematic components, the random residual accounting for all the variations, then the interpretation would be that there is no evidence of economic rationality in our data. Thus, a reasonable (minimum) measure of the degree of rationality implied by our model is the proportion of the variance of the inputs which is explained by their systematic components, that is, by the profit-maximization model.

Estimation of the errors-in-variables equations of log output on log capital, log output on log labor, and log capital on log labor yields estimates of the elasticity of supply of capital and labor as the slope coefficients. Furthermore, it can be shown that the product-moment coefficient of correlation between log capital and log labor is our index of economic rationality, as defined above.

Summary

We constructed a model to test for economic rationality. Using this model, we found that the observed variations in inputs and output in a random sample of owner-operated, mainly self-sufficient farms in the least-developed area of Greece are consistent with profit-maximizing behavior in somewhat imperfect input markets. This is offered as a piece of evidence that traditional agriculture is rational. We do not claim universal validity for our *results*. Our *method* nevertheless is general. The approach and techniques we use require a minimum amount of easily obtainable data and are limited by no institutional constraints. They can, therefore, be used for the measurement and testing of economic rationality in any context, be it in developed or underdeveloped countries.

Discussion: A Test of the Hypothesis of Economic Rationality in a Less-developed Economy*

PAUL R. JOHNSON

Professors Wise and Yotopoulos have presented us with an interesting search for a measure of rationality. The goal is certainly worthy, but this reader is left with the feeling that they have not yet achieved it.

They start with the assumption that Greek peasant farming is characterized by a two-input Cobb-Douglas production function and constant elasticities for the supply of inputs and demand for output. They assume profit maximization and derive three relations involving the values of inputs and outputs where the unknown parameters are the elasticities of supply of the inputs. By making certain assumptions (which I shall discuss shortly) about relationships among variances, they derive as an estimate of a "rationality index" the correlation coefficient between the log of capital and the log of labor.

From the title, I assume that the rationality index is the primary focus of the paper. Therefore, this discussion is devoted largely to the index and only secondarily to the problems encountered in deriving it. The authors conclude that "two-thirds of the variance in input levels is explicable by profit-maximization considerations [and this] is indeed encouraging." In accepting this conclusion as empirical verification of their measure, one should note carefully the alternative that is rejected. By attributing the observed correlation to their systematic component, they thus reject a model that considers entrepreneurial behavior to be entirely random. A model that makes entrepreneurial decisions unpredictable in any systematic fashion is an unlikely candidate for acceptance over almost any other alternative. Further, such a model is not part of the literature of attack on profit-maximization models with which they start. The likeliest alternative—the traditional model—is perfectly consistent with their regressions.¹

Consider a model that said all Greek farmers were taught as young men to apply so much capital and so much labor per unit of land. We could specify this as $K = \alpha L$, capital is a fixed proportion of labor. A

* Part of these comments refer to a longer version of the paper which the reviewer was given for comments.

¹ The other line of attack is not really germane. These writings are concerned with large firms in industries composed of few firms. Galbraith in *The New Industrial State* specifically exempts "dairy farmers in Wisconsin" from his discussions of behavior of firms.

regression of capital on labor should show a high degree of correlation. If we ran such a regression in logs, we should get not only a high degree of correlation but also a coefficient that is an estimate of one. This is precisely their result. They further show, in a footnote, how fixed proportions lead to this result. The test, then, cannot distinguish between a purely traditional and a purely profit-maximizing behavioral model.

As long as rationality is defined as profit-maximizing behavior, the Wise-Yotopoulos index is not a rationality index. It can be used to discriminate between randomness and systematic behavior that leads to a proportional relationship between inputs, but not between the latter and profit maximization.

The authors take cognizance of the Cobb-Douglas restriction and its consequences. Nowhere, however, do they give the reasoning for their assumption in equation (22) that

$$\frac{\text{variance "true" capital}}{\text{variance observed capital}} = \frac{\text{variance "true" labor}}{\text{variance observed labor}} = P.$$

They define P as a measure of the extent to which the firm is successful in setting its inputs at the "correct" level, but they do not discuss the reasonableness of the equality between the two ratios. As they show in Appendix II, and as implied by equation (22), the restriction on the u 's is what allows them to use the correlation coefficient as an estimate of P . But they do not really tell us why the variance of "mistakes" in one input should be the same fraction of variance for that observed input as is the variance of mistakes for the other input.

In a paper as complex as this, one can usually find assumptions not to one's taste, so I will not pursue this matter nor some other quibbles. Even if one accepts the validity of the authors' assumptions, however, the ambiguity in the index would appear to limit its usefulness.

MICRO-MACRO LINKAGES IN THE RURAL ECONOMY

CHAIRMAN: JAMES MARTIN, VIRGINIA POLYTECHNIC INSTITUTE

Micro Goal Functions and Economic Planning*

K. D. COCKS AND H. O. CARTER

ACCEPTANCE of this assignment, with the above title, allows a more precise delineation of the area "where angels fear to tread." On the other hand, one could "wisely" dismiss the assignment by recalling that the goal of both micro and macro planning is maximization of utility, subject to political, economic, and other environmental restraints. However, unless we can specify some content for empty utility functions, which is highly unlikely, this approach has only the merit of brevity, allowing us to present the shortest paper on record.

A less extreme, less brief, but perhaps more revealing approach is to undertake to look at the similarities as well as the dissimilarities of goal functions used in empirical micro planning and the objectives considered in macro planning studies. The commonality between firm growth and general economic growth has been noted by Baumol [1, p. 88], among others. Baumol states, "Though not all attempts by individual firms to increase their size will add to national output (as when the company expands by merger), much of this expansionary effort will, in fact, make for growth of the entire economy." But macro economic planners are generally faced with multiple goals. Marglin [11, p. 19], for example, stresses four objectives most relevant to investment planning in the public sector: (1) to increase aggregate consumption, (2) to redistribute consumption, (3) to fulfill "merit wants," and (4) to promote national self-sufficiency. While further variations and subclassifications of goals are found in the literature, the consumption goal is generally recognized and emphasized by most macro planners and theorists. This has its counterpart in investment decision theory or capital budgeting, largely based on Irving Fisher's classic analysis which regards investment as only a means for distributing consumption over the course of time [8].

Why, then, offered precedents in the fields of macro theory and investment planning, have agricultural production economists stressed maximization of profits and rates of return and given so little acknowledgment to

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the importance of consumption and wealth? Why doesn't the production economist, evolving plans for the farmer (who is both a consumer and a producer), make more use of goal functions based on the twin concepts of wealth and consumption? Is it possible to interpret the commonly used goal functions of the production economist in terms of these concepts? Would greater realism be achieved if the micro economist borrowed these concepts from his macro planning counterpart? What are the conceptual and methodological difficulties of planning with goals based on consumption and wealth? This, then, is one facet of the relationship between micro and macro planning—*how readily do macro goals transfer to the micro sphere?* We devote the first three sections of our paper to this question. That is, we consider (1) the goal functions used in contemporary micro studies, (2) specification of wealth-consumption goals, and (3) an empirical example of planning with wealth-consumption goals. A second facet of the same relationship is the two-way interaction between the actions of individuals and those of the planner. We conclude the paper with some tentative comments on (4) the connection between micro and macro planning.

Contemporary Micro Goal Functions¹

The prime source of goal functions in micro planning has been the insights of economists interested in the theory of the firm, or perhaps, following Papandreou [15], the theory of the entrepreneur. There is, for example, the classical short-run "profit" or "net revenue" maximization, which is given comprehensive expression by Carlson [4]. These firms, Boulding [3, p. 4] states, are "creatures without past or future, balance sheet or net worth." The Lutzes [10, p. 6], among others, point out that once we introduce "fixed" capital or durable goods, we cannot assume, even under the simplest conditions, that the firm is interested in the operations of only one short period of time. Subsequent development extended the static one-period approach of the early production theory by assuming a finite number of time periods, with demand and cost functions different, but still known exactly, in each time period. The problem was then defined as one of maximizing some quantity which measures profitability, usually total discounted profits, over the assumed time horizon.

Provided that the entrepreneur obeys certain preliminary optimizing rules, the multiperiod problem can be expressed equivalently in terms of (aggregate) investment expenditures and revenues. This represents a movement from the theory of production to the theory of investment. Fisher was able to show that, for two periods and a perfect capital market, each individual should choose the investment program which maximizes the present value of his investment at the current market rate of interest and then

¹ We shall not be considering the introduction of noncertainty or the potentially important areas of lexicographic and satisficing goals.

borrow or lend at the market rate to achieve his maximum utility over a period of time [8].

At this point in the search for the "ultimate" investment criterion, a certain vagueness enters the literature. It is induced, perhaps, by an apprehension of the complexity of multiperiod functions, but also by a lack of agreement as to what the entrepreneur should or does maximize in the longer run and the constraints under which such maximization takes place.

The Lutzes [10, p. 13] suggested four possibilities:

First, the entrepreneur may find the present value of the future gross revenue stream (v) and the present value of the future cost stream (c) by capitalizing at the interest rate ruling in the market, and maximize the difference ($v-c$) between these present values. Secondly, he may maximize the present value of the future revenue stream (again formed by capitalizing at the given market rate of interest) divided by the present value, similarly calculated, of the future cost stream, i.e., he may maximize v/c . Thirdly, he may maximize the "internal rate of return" on the capital sum invested. Fourthly, he may maximize the rate of return on his own capital, which is assumed to be a given amount and may be smaller than the total sum invested whenever part of the latter is financed out of borrowed funds.

In contrast, Scitovsky proposes, as the investment criterion, the maximization of profit per unit of capital invested, in response to the observation that capital is the fixed factor generally limiting the size of the firm [17]. Hirshleifer argues convincingly, in a generalized Fisherian framework which delineates productive and market investment opportunities, that, while no rule is universal, the present value rule is correct in a wide variety of cases; but more importantly, he shows that the relevant rate of discount for the firm's decisions in the nonperfect capital market involves, as an integral consideration, the consumption decision [9].

More recently, Baumol [2, p. 193] records the suggestion that firms often seek to maximize the money value of their sales, subject to a constraint that their profits do not fall short of some minimum acceptable level.

Other writers, Williamson [19], for example, have seen the firm as being concerned with such parameters as size of capital stock, discretionary returns to management, and staff size.

Students of the theory of financial management provide us with slightly different viewpoints. Solomon [18, p. 20] draws attention to the maximization of wealth or net present worth as an operating objective for financial management. This concept differs from the ($v-c$) of the Lutzes in that Solomon requires his discount rate to reflect subjective degree of certainty. The goal of maximizing the discounted cash flow (DCF) rate of return [13] is usually applied in the selection of expansionary investment projects, but there seems to be no reason why this should not be translated into a global objective for the firm. Actually, there appears to be no substantive difference between internal rate of return and DCF rate of return [16, p. 200].

It would appear that the theory of the firm, loosely interpreted, suggests a variety of possible goals for the entrepreneur.

Specification of Wealth-Consumption Goals

Consumption theory under certainty postulates the maximization of ordinal utility through the consumption of goods giving ultimate satisfaction, subject to a single or multiperiod budget restraint. Generally, the utility index can be expressed as a function of periodic aggregate consumption expenditures and, presumably, it is at this resolution that we would wish to work in a farm planning model.

Terminal wealth or net worth has been almost wholly ignored in micro agricultural planning. Edwards [6], following Glenn Johnson's fixed asset theory, has said, "We have become preoccupied with flows of services and of products which affect the flow of profits to the farm business. In so doing, we have neglected the *stock of assets* [italics ours] which are reflected in the farmer's balance sheet."

How, then, do we move from received goal functions to wealth-consumption goals? Consider a symbolic expression of the classical long-run goal:

$$(1) \quad \text{Max} \sum_{j=1}^n \alpha_j P_j,$$

where

P_j is the farming profit in the j th year of an n -year planning period, and α_j is a discount factor derived from δ , a single discount rate.

Profit, P_j , can be analyzed as

$$(2) \quad P_j = R_j - (C_j + D_j)$$

where

R_j is farming returns (assumed cash) in the j th year,

C_j is cash costs in the j th year, and

D_j is noncash costs (assumed to be depreciation) in the j th year.

Equation (2) can be restated to isolate the cash *surplus* in the j th year:

$$(3) \quad R_j - C_j = P_j + D_j.$$

Cash surplus equals profit plus depreciation and must be distinguished from cash *flow*, the monies withdrawn from the business.

Cash on hand at the end of the j th year equals cash surplus plus cash costs, assuming that any use of cash is treated as a cost; that is, cash on hand equals cash returns.

Broadly, there are two uses to which the farmer can put his cash on hand. Firstly, he can withdraw it, regarding it simply as a cash flow; or he can withdraw it and earmark it for consumption. Secondly, he can reinvest

it. We normally assume consumption or cash flow to be any spending that cannot be recovered for use in the farm business.

Given these two uses, we can state that cash on hand is divided between cash flow/consumption and investment:

$$(4) \quad R_j = S_j + I_j$$

where

S_j is cash flow or consumption, and

I_j is investment ("retention" might be a better word).

It follows from (3) and (4) that

$$(5) \quad P_j + D_j + C_j = E_j + I_j$$

$$(6) \quad P_j = S_j + (I_j - D_j - C_j)$$

$$(7) \quad = S_j + N_j$$

where N_j = net investment.²

This interpretation of profit can be plugged into the classical goal:

$$(8) \quad \text{Max} \left[\sum_{j=1}^n \alpha_j S_j + \sum_{j=1}^n \alpha_j N_j \right].$$

Expressed in this way, the classical goal implies that as long as reinvested funds can increase profit by any positive amount at a later date, they will never be withdrawn. This effectively means that all profits are reinjected as they eventuate, and the classical goal reduces to the maximization of a rather strangely weighted aggregation of terminal net worth elements:

$$(9) \quad \text{Max} \sum_{j=1}^n \alpha_j N_j.$$

One way of avoiding this position is simply to maximize terminal net worth, disregarding the dates at which elements of it are generated:

$$(10) \quad \text{Max} \sum_{j=1}^n N_j.$$

Another way of avoiding the difficulty is to require that profits be wholly withdrawn and the present value of withdrawn profits be maximized:

$$(11) \quad \text{Max} \sum_{j=1}^n \alpha_j S_j.$$

² We note that the existence of borrowing and lending does not alter this definition, although we may have to recall that retained funds can be used for principal repayments and, hence, for the buildup of equity by simultaneously adjusting both sides of the balance sheet.

subject to

$$(12) \quad S_j = R_j - (C_j + D_j).$$

Expressed in this way, the classical goal maximizes present withdrawals subject to an unnecessary constraint. Even if the value of the program could be increased by withdrawing cash in excess of profits, this is not permitted.

We might adopt (11) as an unconstrained goal and call it maximization of present consumption. However, utility considerations would then require that quantity as well as time discounts be introduced, for example,

$$(13) \quad \text{Max} \sum_{j=1}^n [\alpha_{1j} S_{1j} + \alpha_{2j} S_{2j}],$$

where

S_{1j} represents withdrawals up to some critical level in the j th year,

S_{2j} represents withdrawals in excess of this critical level in the j th year, and

α_{1j} , α_{2j} are appropriate weighting factors reflecting both time and quantity preference.

The weakness with the present consumption goal, as defined here, is that it ignores the value of terminal net worth. If we define terminal net worth as just another cash flow, we have the goal of maximizing the present value of future cash flows³:

$$(14) \quad \text{Max} \left[\sum_{j=1}^n \alpha_j S_j + \alpha_n \sum_{j=1}^n N_j \right].$$

To reflect the utility of consumption while still recognizing terminal net worth, we might maximize the present value of future consumption and terminal net worth:

$$(15) \quad \text{Max} \sum_{j=1}^n [\alpha_{1j} S_{1j} + \alpha_{2j} S_{2j}] + \alpha_n \sum_{j=1}^n N_j.$$

As already noted, this maximand fails to recognize the special nature of terminal "consumption." The unique interest of the terminal-state vector of the system is that it is the initial-state vector for the subsequent planning period. The point becomes difficult to discuss under assumed certainty, but we note that unless the opportunities and parameters of the subsequent planning period are known, this terminal-state vector cannot be evaluated in the same way as intraperiod parameters. Even if the postplanning environment is known, we encounter the paradox that in evaluating the terminal-state vector we are, in effect, extending the planning period. Prob-

³ This is purely terminological. We change the name of cash withdrawals from "consumption" to "cash flow" on including net worth in the goal function and giving quantity discounts.

ably the best that can be done is to throw the problem back to the farmer and ask him to choose among (apply a preference function to) an efficient set of vectors each containing terminal and intraperiod elements. The idea is analogous to that used in Markowitz's expectation-variance analysis of portfolio selection [12, p. 129].

When we maximize the DCF or internal rate of return, we are indentifying a set of cash withdrawals and a terminal net worth such that

$$(16) \quad M = \sum_{j=1}^n \frac{1}{(1+\delta)^j} S_j + \frac{1}{(1+\delta)^n} \left(\sum_{j=1}^n N_j + M \right)$$

where M is opening net worth and δ is a maximum.

The well-known weakness of this criterion is that it assumes the rate-of-time preference to equal the maximum internal rate of return.

Spin-off of Consumption and Wealth

The foregoing discussion has thus revealed seven goals concerned, ultimately, with the spin-off of cash at each stage and the value of terminal assets:

1. Maximization of the present value of future consumption.
- 2 and 3. Maximization of the present value of future profits, both (a) in the situation where profits are withdrawn at the end of each accounting period and (b) in the situation where profits are reinvested as they eventuate.
4. Maximization of the DCF rate of return.
5. Maximization of the present value of future cash flows.
6. Maximization of terminal net worth.
7. Selection of the most preferred point on an efficient locus showing present consumption versus terminal net worth. The corresponding extremum problem would be maximization of a preference function which included present consumption and terminal net worth as arguments.

Differences in these spin-off goals lie simply in the way in which the components of the spin-off vector are weighted and constrained in each case. Recognition of this underlying unity leads to the idea that goal functions could be set up in terms of the fundamental desiderata of consumption withdrawals and terminal net worth, rather than secondary, displaced parameters [14, p. 155]. All of these goals can be built into a multistage linear programming model, although DCF rate of return has to be maximized by successive approximation.

An Empirical Example of Planning with Wealth-Consumption Goals

An outline of the multistage linear programming matrix is presented in Table 1. It represents a simplified version of the problem of planning a turkey farm, over an extended horizon. A three-year period is specified,

where activities include a choice of technologies, type of housing, borrowing and lending options, and payment of income tax. Activities and restraints are the same each year, so only first-year and some border coefficients are shown. The years are linked horizontally by capital transfer and vertically by the multiperiod borrowing and building activities. For simplicity, a common time-preference rate of 10 percent was used throughout. Additionally, consumption above \$2,000 in any year was discounted a further 10 percent to imply a diminishing marginal utility for extruded cash.

The seven different goal functions used, with the same A matrix, are the spin-off goals already discussed. Recall that the difference between present consumption and present cash flows is that cash flows are not discounted for quantity, and terminal net worth is not included as a consumption increment (although it does emerge passively.) Taxation in any year is 10 percent of profit. Income tax appears in the model but not in the earlier discussion because, there, it is simply another cost, distinguished by being a function of taxable income. Long-term loan funds are amortized over 20 years at 5.5 percent and the interest portion of the annual payment treated as a cost.

The functional coefficient for the payoff column under the consumption-terminal net worth goal is varied parametrically from 0 to 10. "Payoff" now throws off terminal net worth, including \$25,160 of depreciated opening structural assets.

The resultant spin-off vector for each of seven goals is presented in Table 2. Only two goals gave the same spin-off-terminal net worth and present cash flows. With a higher discount rate, even this similarity would have vanished. We draw the casuistic conclusion that plans are sensitive to goals and that, in setting up wealth-consumption goals, choice of weightings is likely to be critical.

It may be of interest to point out the relationship between these models and the Fisher-Hirshleifer approach. Our "technology" matrix defines the bounds on wealth-consumption possibilities, including borrowing and lending, in one operation rather than in two. Our different goal functions are then alternative hyperplanes which are used to identify the optimal corner on the efficient wealth-consumption set, depending on the nature of assumed preference.

In policy terms, our wealth-consumption locus is analogous with the Pareto-optimal set of alternatives of the welfare economist. When he applies a social welfare function to this set, without being able to use the redistribution possibilities of a perfect capital market [11, p. 96], this too parallels the actions of the individual farmer.

The Connection Between Micro and Macro Planning

The impact on the individual farmer of any change in economic policy, be it in interest rates, credit availability, taxation, market manipulation, or

Table 2. Spin-off vectors for seven goals

Goal	End year 1	End year 2	End year 3	Terminal net worth
	<i>dollars</i>			
Present value of future profits				
(a) Profits withdrawn	4,932	6,324	7,636	40,000
(b) Profits reinvested	0	0	0	61,180
Terminal net worth	0	0	0	61,198
Present consumption	13,517	15,383	13,009	12,616
Present value of future cash flows	0	0	0	61,198
DCF rate of return (= 15.7 percent p.a.)	13,517	13,121	0	28,767
Aggregate present consumption versus terminal net worth (efficient points)	13,517	15,383	13,009	12,616
	13,517	15,361	13,028	12,628
	13,517	14,985	13,350	12,833
	13,517	14,303	13,935	13,207
	13,517	13,359	14,731	13,710
	9,244	16,302	16,096	14,574
	2,000	18,833	21,036	16,040
	2,000	18,833	18,933	18,263
	2,000	16,651	16,994	22,860
	2,000	2,000	20,225	36,109
	2,000	2,000	2,000	54,334
	0	2,000	2,000	56,949
	0	0	2,000	59,198
	0	0	0	61,198

public investment, is to change his economic possibilities and, hence, his economic activities. He attempts to achieve a most preferred state within the new environment.

The macro policy maker, on the other hand, is attempting to identify that set of policy changes which, in cost-benefit language (say), maximize the anticipated increase in net social benefit [7], that is, the net addition to present consumption which it is anticipated will flow from the new policy. In principle, in order to predict the change in net social benefit accompanying a policy change, it is necessary to predict change in the consumption profiles of individuals, and then aggregate. Thus, the farmer and the planner respond to each other.

If we have been successful in reducing some contemporary micro goals to terms of wealth and consumption, we have identified a happy correspondence between micro and macro thinking. Both the farmer and the nation act as though they are seeking a desirable wealth-consumption profile, albeit we know little of the preference weightings associated with such profiles. Does this, however, enable us to see more clearly the relationship between micro and macro planning? Probably it does little more than facilitate measurement of the contribution to net social benefit accompanying the normative response of a single farmer to some policy change. Any policy change can be interpreted by the individual as a direct change in his planning coefficients. This changes his planned consumption profile, a change

which can be aggregated at the social time-preference rate instead of at the personal rate.

Apart from the work involved, there are at least two reasons why it is inappropriate to evaluate macro policy by thus aggregating changes in consumption profiles for individuals or for representative individuals:

1. Planning coefficients will be changed, not only directly, but also indirectly, by any policy change, mainly via the market mechanism.
2. Individuals' responses will be positive and not normative.

Part of the problem of linking micro and macro planning is that we do not have positive workable models for either which recognize the existence of the other. On the macro side, some movement in this direction is occurring in public investment planning, where positive behavioral aspects can be suppressed, and in regional planning, where the individual is more significant relative to the macro entity. On the micro side, we have little more than the recursive programming approach [5].

But isn't this perhaps the way things should be? Just as the Newtonian physicist successfully studies the movements of bodies without reference to atomic or nuclear physics, so the quantitative policy maker, with his target and instrumental variables and his consumption and investment functions, is starting to understand the economic "body" without reference to the latest advances in management techniques or the measurement of individual utility functions. Even if we could successfully link micro and macro planning, it might not be the most useful thing to do.

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Discussion: Micro Goal Functions and Economic Planning

K. R. TEFERTILLER

This paper deals with a relevant problem area. We know relatively little about micro-macro linkages in the rural economy.

The authors' discussion of micro goals may lead the reader to believe that the number and variety of goals for the entrepreneur are greater than is really the case. The nine goals presented could be reduced to four or five. Another statement by Boulding in the same paragraph from which the authors have quoted is also relevant to the question of number and kinds of goals:

A still unresolved controversy revolves around what quantity is the measure of whole-life profitability. The weight of the majority inclines toward taking the present value of the future net revenues at market rates of interest as the measure of the optimum. A minority incline toward the internal rate of return or the rate of profit which is actually earned on the investment in the enterprise as a better measure. The controversy is, however, swallowed up in a larger one about whether any objective measure of the optimum is possible, for if no objective measure is realistic the argument about which of two wrong measures is right loses a lot of interest [1, p. 4].

The results in Table 2 regarding the effects of differences in firm-household goals on the growth of a turkey farm are interesting, but it is difficult for me to see how these results can be of much use to economic planners. Policy variables were taken as givens in the model.

I do not completely agree with the authors' statement, "Terminal wealth or net worth has been almost wholly ignored in micro agricultural

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planning." Recent studies by J. R. Martin [4], S. R. Johnson [3], and B. R. Eddleman [2] explicitly include terminal wealth in their models. Martin considers several goal functions involving wealth and consumption. He concludes, "The environment within which farm operations occur tends to overwhelm specific operator objectives whether they be to maximize returns, sales, farm size, owned capital or reinvestment capital, or even consumption." He found that all of these objectives tend to maximize capital accumulation. These studies indicate that the structure of the system is the important factor, not different goal functions. Credit policy, initial asset position, consumption policy, taxes, and interest rates are some of the more important variables which influence capital accumulation.

The major weakness of the model presented in this paper is the failure of the analysts to relax the "givens." The emphasis of the analysis is on measuring the effect of different goals under "given" conditions. In my judgment, it is essential to vary the structure of the system in order to begin to understand the micro-macro linkage. It is important to recognize that economic planners are concerned with the impact of changes in the system for the individual and the economy because these are the variables that can be influenced directly. Assuming that an economic planner had nearly perfect knowledge about how individual producers progressed under a set of "givens," he would still be helpless until he knew something about the response of producers and consumers to change in the structural variables of the system that can be manipulated.

Economic planners have relatively little influence in altering individual goals. They are likely to be more interested in producers' response to changes in the system under different goals than in a detailed analysis of the effect of goals on accumulation of wealth. Generally, what is taken as "given" in the micro models is the values to be "determined" in the macro models. Both micro and macro planning involve production and consumption over the course of time. However, only macro models involve personal distribution of income.

The authors attempted to maximize seven spin-off goals at the firm level, given a set of policy and technological constraints. More progress toward understanding the micro-macro linkage would have resulted from selecting one or two goals and relaxing several of the policy and technological constraints.

My major criticism of this paper is that the authors have taken a model largely oriented with considerable specificity to micro planning and have loosely related it to macro planning through goal functions. They have failed to integrate micro and macro planning because the macro variables have not been explicitly included in the model. If we are to make progress toward linking micro and macro theory, we must find appropriate ways to incorporate both micro and macro variables into our models.

There is work going on in our department at the University of Florida which involves a model that incorporates both micro and macro variables.¹ This work empirically confronts the pesticide issue in an attempt to determine the "best" (in a social-welfare-maximizing sense) use of pesticides from society's point of view. The model uses the concept of consumer and producer surplus as a measure of "welfare" and maximizes over alternative policies concerning pesticide use and levels of production of individual crops. The maximization is net of the relevant measurable externalities and is constrained by resources available to producers in the area.

In closing, I would like to congratulate the Association on devoting a portion of its program to the interface of micro and macro theory. Our being here emphasizes the strong current trend in economics toward a systems approach to problems. This emphasis is not unique to economics. Indeed, the thrust in all areas of science is toward a systems approach.

Historically, the analyst confronted the level of aggregation as a multiple choice hypothesis. Once he had made his choice, he proceeded with the analysis. With the systems approach the level of aggregation loses some of its interest. The challenge becomes one of confronting the important decision variables in all parts of the system and of capturing the interaction of these variables in a formal framework.

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Industrial-Urban Development and Rural Farm Income Levels*

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The question as to why some rural communities are poverty-stricken while others are prosperous has engaged the interests of economists for some time. And, given the current "War on Poverty," the question is of interest also to policy makers and program administrators. The answer is important in deciding the optimal program mix in poverty-stricken areas. Specifically, what is the appropriate combination of investments in the area, investments in the area's people, and transfer payments? The analysis in this paper provides some information relevant to these issues.

The industrial-urban development hypothesis, together with hypotheses about the effects of local characteristics, is employed to explain intercounty differences in the per capita income of rural farm people in 1959. Data from the 1959 Census of Agriculture [13] and the 1960 Census of Population [12] were used to conduct a cross-sectional analysis of thirteen regions in the coterminous United States.

Hypotheses

It is hypothesized that the average income of rural farm people per county depends upon the county's location relative to centers of industrial-urban growth, the sizes of the centers, the characteristics of the county's economy, and demographic characteristics of the county's rural farm population. The effects of these factors are hypothesized to vary both by region and by the color of the rural farm population.

Rural income levels are affected by industrial-urban development in two ways. They are influenced, first, by the extent of local industrialization within a county and, second, by the presence of centers of industrial-urban development in surrounding counties.

Industrial-urban development is accompanied by an influx of nonfarm capital. The effect of this influx is to expand the supply of nonfarm jobs, draw labor out of agriculture, raised agriculture's capital-labor ratio, and expand the demand for farm products. Because of the expanding size of the product and factor markets, productivity is hypothesized to increase via specialization. To the extent that there is a concomitant increase in social overhead capital, the costs of transportation and market informa-

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tion decrease, thereby resulting in an expansion of the market areas for both products and factors. Furthermore, industrial-urban development may reduce nonfarm job rationing and capital rationing against agriculture¹ [2, 7, 8, 11]. Schultz, who formulated the modern version of the hypothesis, also postulated a decline in the dependency ratio, an increase in the continuity of employment, and an increase in the investment in human capital as industrial-urban growth proceeds [8]. These factors bring about an increase in per capita rural farm income in the community in which such growth occurs and also in outlying communities.

The industry structure of nonfarm employment in a county is a measure of both the nature and the extent of local industrialization. The specific variables used are the percentages employed in primary, secondary, and tertiary industries, respectively.² The county's location relative to centers of industrial-urban development and the sizes of the centers are represented by a single variable. This variable is the sum of the ratio of the population of each Standard Metropolitan Statistical Area (SMSA) within 200 miles of a county and the distance between the SMSA and the county. Thus, the influence of no SMSA was assumed to extend farther than 200 miles. Centers smaller than SMSA's were assumed to influence per capita income only in the county in which the center was situated.

Two other local economic characteristics were included in the analysis: the value of farmland and buildings per farm worker in a county and the percentage of the county's labor force working 39 weeks or less in 1959. The former variable is a weak proxy for the capital-labor ratio in agriculture; its adequacy depends both on the variability within each region in the proportion of total farm capital accounted for by land and buildings and on the seasonality of the demand for farm labor. The latter variable represented the extent of long-term unemployment in each county and, therefore, the overall condition of the local labor market [9].

Age and formal schooling are the demographic characteristics of the rural farm population included in the analysis. The average age of the rural farm population is a measure of the dependence and experience of rural farm people. The average years of school completed and the third moment of years of school completed are included to reflect the average investment in education and the degree of skewness in the distribution of education among rural farm people.³

The age and education variables were defined on the white rural farm population in the white equations and on the nonwhite rural farm popula-

¹ The work of Johnson [4] suggests that factor market imperfections have only minor effects on efficiency.

² The Appendix contains a precise specification of the variables.

³ The third moment is positive if the distribution is skewed to the right, negative if skewed to the left.

tion in the nonwhite equations. All other variables used in the analysis were defined on the county. Because almost all of the nonwhite rural farm population is located in the South, the nonwhite equations were estimated only for the southern regions.

The regions used were those devised by Bogue and Beale [1]. Even though the regions were identified by the use of data from the 1950's, they are quite adequate for an analysis using 1960 data. The regions are shown in Figure 1.



Figure 1. Economic regions of the United States

Results

The results of estimating regression equations incorporating the hypotheses of the previous section are presented in Tables 1 and 2. The results are first discussed for the "white" equations and then for the "non-white" equations.

The white results

Age and education.—The coefficients of the age and education variables were expected to be consistent with the results of studies of the relationship between age, education, and the income of persons [5]. Thus, the coefficients of mean age and education were expected to be positive. The coefficient of the third moment of the education distribution was

Table 1. Estimated coefficients from regression equations for per capita white rural farm income

Region	Mean age X_1	Mean educa- tion X_3	Third moment of educa- tion X_5	Percentage primary employ- ment X_7	Percentage secondary employ- ment X_8	Percentage tertiary employ- ment X_9	Percentage working 39 weeks or less in 1959 X_{10}	Value of farmland and buildings per worker X_{12}	Proximity to SMSA's X_{13}	R^2
Expected sign	+	+	-	+	+	+	-	+	+	
I	21.9694* (8.2016) 0.1636	276.023* (29.7303) 0.5851	0.5090 (1.1761) 0.0150	-2.8369 (20.3315) -0.0132	8.2422 (5.0976) 0.1574	11.9036 (5.7947) 0.2055	-27.1729* (8.0841) -0.3294	0.3827 (1.2525) 0.0206	27.9078 (17.0907) 0.1037	0.69
II	2.9675 (6.9675) 0.0256	215.119* (38.5963) 0.3449	-1.3024 (2.4964) -0.0344	-4.4779 (13.4889) -0.0213	-0.0516 (2.5608) -0.0014	1.0706 (2.7335) 0.0252	-14.1635* (5.5304) -0.1845	8.7552* (1.0324) 0.5238	349.739* (91.9339) 0.2347	0.65
III	-15.3881 (9.6358) -0.0892	206.380* (41.6614) 0.2896	-6.7228 (3.6166) -0.1099	3.5675 (6.3104) 0.0443	17.2926* (3.9984) 0.3859	15.2313* (4.5821) 0.2462	-9.6748* (4.8490) -0.1212	4.6228* (1.4523) 0.1956	82.7784* (16.4070) 0.2973	0.74
IV	-20.4602* (8.1386) -0.1689	209.952* (38.9139) 0.3843	-5.8096 (3.4956) -0.1136	7.9590* (3.3518) 0.19545	12.3777* (2.2738) 0.3834	8.1486* (2.5904) 0.2389	-10.1866* (3.4761) -0.2520	4.9055 (2.8145) 0.1274	56.5659 (92.9858) 0.0430	0.52
V	-0.4907 (3.3722) -0.0045	166.818* (24.2152) 0.2219	-8.7243* (2.5041) -0.1084	7.4278 (5.7926) 0.0383	13.9550* (0.9507) 0.4972	5.5620* (1.3045) 0.1321	2.0082 (2.6727) 0.0233	0.0808* (0.02448) 0.0969	572.917* (86.1720) 0.2241	0.65
VI	-16.6521* (7.2232) -0.0988	238.479* (37.1825) 0.2954	-9.2811* (2.6991) -0.1369	4.5635 (4.8826) 0.0364	3.2225 (3.4909) 0.0428	-0.2938 (2.1762) -0.0062	7.1015 (4.3273) 0.0676	9.1873* (0.9204) 0.4560	197.605 (642.822) 0.0128	0.53
VII	-11.8028* (4.6475) -0.0790	222.010* (17.7824) 0.5100	2.4661 (1.5926) 0.0523	2.9231* (1.3753) 0.0753	4.9450* (1.0568) 0.1543	7.6310* (1.1757) 0.2139	-17.9473* (1.5381) -0.3579	0.7269* (0.2818) 0.0769	341.026* (70.8509) 0.1365	0.68

(Continued on following page)

Table 1. (Continued)

Region	Expected sign	Mean age X_1	Mean education X_3	Third moment of education X_5	Percentage primary employment X_7	Percentage secondary employment X_8	Percentage tertiary employment X_9	Percentage working 39 weeks or less in 1959 X_{10}	Value of farmland and buildings per worker X_{12}	Proximity to SMSA's X_{13}	R^2
		+	+	-	+	+	+	-	+	+	
VIII		3.4095 (5.0918) 0.0252	242.116* (20.5267) 0.5797	2.9916 (1.7626) 0.0767	0.7574 (5.6007) 0.0046	6.0667* (1.4820) 0.1924	10.0483* (1.6260) 0.2662	-2.8679 (2.3893) -0.0508	-0.1850 (0.1347) -0.0472	513.703* (104.317) 0.1717	0.55
IX		13.4794 (8.6531) 0.1042	229.854* (35.9939) 0.5844	2.0055 (1.9549) 0.0865	3.3295 (8.1152) 0.0307	-14.0721* (4.0873) -0.2464	3.8215 (4.6612) 0.0664	-18.8904* (8.4821) -0.1592	0.4644 (0.8744) 0.0357	320.257 (317.232) 0.0722	0.38
X		-41.7598* (3.3981) -0.3280	232.788* (30.3036) 0.3683	-0.6786 (2.2243) -0.0138	18.6727* (4.6657) 0.1918	-1.6094 (2.3600) -0.0270	3.8935 (2.4012) 0.0630	-4.2452 (3.1036) -0.0599	7.4482* (1.1794) 0.3181	375.393 (250.640) 0.0573	0.66
XI		-5.8139 (9.7932) -0.0347	220.339* (46.1960) 0.2849	-4.3082 (2.7929) -0.0922	8.5044 (4.7657) 0.1133	4.0913 (5.2254) 0.0499	6.4047 (4.0214) 0.0998	-31.6881* (6.8313) -0.2850	6.0783* (1.6380) 0.2234	17.2203 (1050.75) 0.00096	0.27
XII		4.9831 (16.8730) 0.0281	377.740* (146.9690) -0.3298	-17.7781* (6.1868) -0.2489	-52.1335 (33.0893) -0.1476	-8.0258 (5.8083) -0.1773	-16.8714* (6.4053) -0.2838	-10.8112 (8.2114) -0.1228	4.6664* (2.0781) 0.2618	586.734* (268.469) 0.2036	0.64
XIII		-5.6958 (18.1208) -0.0470	308.684* (75.9829) 0.5691	-18.9524* (6.2508) -0.3805	24.2036* (7.6457) 0.4542	2.4995 (7.5560) 0.0484	-6.6978 (8.1388) -0.1280	-22.8421 (13.0845) -0.3211	0.5986 (1.8324) 0.0369	49.9680 (48.0126) 0.1210	0.63

* Significantly different from zero at the 5-percent level.

Table 2. Estimated coefficients from regression equations for nonwhite rural farm income

Region	Mean age	Mean education	Third moment of education	Percentage primary employment	Percentage secondary employment	Percentage tertiary employment	Percentage working 39 weeks or less in 1959	Percentage nonwhite rural farm females working in 1959	Value of farmland and buildings per worker	Proximity to SMSA's	R ²
Expected sign	X ₂	X ₄	X ₆	X ₇	X ₈	X ₉	X ₁₀	X ₁₁	X ₁₂	X ₁₃	
VII	+	+	-	-	+	+	-	+	+	+	0.34
	4.4689* (2.2493) 0.1132	95.1176* (12.5626) 0.4311	-1.6243 (1.6263) -0.0392	3.7133 (4.5386) 0.0407	1.6813 (3.4604) 0.0223	2.9150 (3.4825) 0.0348	-3.9291 (4.9432) -0.0333	4.0051* (1.3196) 0.1282	-0.4476 (0.9515) -0.0202	219.979 (241.209) 0.0375	0.34
VIII	+	+	-	-	+	+	-	+	+	+	0.36
	5.4088* (1.3428) 0.1668	53.1093* (7.3244) 0.3015	1.6142* (0.4782) 0.1329	3.0395 (3.4616) 0.0363	1.9557* (0.8721) 0.1209	2.6202* (0.9647) 0.1353	-3.4424* (1.4916) -0.1190	2.8675* (0.6579) 0.1822	0.1430 (0.0833) 0.0711	128.738* (65.5749) 0.0839	0.36
IX	+	+	-	-	+	+	-	+	+	+	0.44
	3.7874 (2.1632) 0.1278	70.1846* (14.5358) 0.3885	-0.8784 (0.9913) -0.0556	-0.2687 (6.4671) -0.0030	0.03490 (3.2205) 0.0007	3.3942 (3.6223) 0.0706	-5.7967 (6.5903) -0.0385	4.7118* (1.2790) 0.2568	-0.0769 (0.7094) -0.0071	415.650 (215.840) 0.1122	0.44
X	+	+	-	-	+	+	-	+	+	+	0.23
	22.4495* (4.1634) 0.3595	14.9220 (23.7426) 0.0438	-4.4779 (2.6524) -0.0962	2.2151 (10.3667) 0.0147	1.3430 (5.1675) 0.0145	-3.5127 (5.5975) -0.0371	-7.2451 (7.1630) -0.0660	7.5005* (2.4069) 0.1785	3.5270 (2.6642) 0.0968	52.5237 (586.574) 0.0052	0.23

* Significantly different from zero at the 5-percent level.

expected to be negative, reflecting the fact that the more negative the third moment, the greater the proportion of highly educated people in the population.

The coefficient of mean age had the expected positive sign in only four regions. Examination of the relationships between mean age and the age distribution for the white rural farm population, however, revealed that a negative relationship between mean age and income per capita is more reasonable. The age structure of the white rural farm population was such that mean age and the percentage over 45 years were very highly correlated in all regions. The negative coefficient of mean age, therefore, reflects both the lower labor force participation and the lower productivity accompanying advanced age.

The results of the education variables indicate the very great importance of formal schooling in the determination of white rural per capita income. The coefficient of average years of school completed was relatively stable among regions, estimated with considerable precision as measured by the *t* ratio, and very important in explaining intercounty variations in the per capita income, as measured by the beta coefficient.⁴

The coefficient of the third moment of the education distribution had the expected sign in 9 of the 13 regions, reflecting the positive effect on per capita income of relatively numerous highly educated people in the white rural farm population. This influence is most important in the two Pacific Coast regions (XII and XIII), the Corn Belt (V), and the Central Plains (VI).

Local industry structure.—The three variables, the percentages employed in primary, secondary, and tertiary industries, refer to the employed civilian labor force per county. They reflect the local nonfarm labor market faced by rural farm people. Together, percentages in secondary and tertiary employment represent local industrial-urban development and thus reflect product market phenomena also, especially the percentage in tertiary employment, in which trade and service employment predominate. The coefficients of all three variables were expected to be positive.

The coefficients of the percentage in primary employment had the expected positive sign in 10 of the 13 regions. In regions IV, VII, X, and XIII the coefficients were estimated with precision. Forestry and iron are important in the Upper Great Lakes region; forestry and coal mining are important in Central and Eastern Upland region; oil and gas are important in the Southwest Plains and mining is important in the Pacific Southwest [1].

⁴ The beta coefficient is the estimated number of standard deviation unit changes in the dependent variable resulting from a *ceteris paribus* change of one standard deviation in the independent variable.

The overall results for percentages in secondary and tertiary employment were consistent with expectations. In region IX, the Gulf Coast region, the coefficient of the percentage in secondary employment was negative and estimated with precision; the same was true for the percentage in tertiary employment in the Pacific Northwest region (XII).⁵ Both variables had significant positive effects in regions III, IV, V, VII, and VIII. In addition, the percentage in tertiary employment was important in the Atlantic Metropolitan Belt. All of these regions comprise or are adjacent to the Industrial Belt, the area between Boston, Washington, and Chicago. The nonsignificance of both variables in the Northeastern region probably reflects the depressed state of this region in the latter part of the 1950's [14]. The two variables representing local industrial—urban development did not have significant positive effects on white rural farm income elsewhere in the country.

Other local economic characteristics.—The index of long-term unemployment, the percentage employed 39 weeks or less in 1959, refers to the country as a whole and reflects overall conditions in the local labor market. Its coefficient was expected to be negative. For the white rural farm population, the coefficient was negative in all regions except in the Corn Belt and Central Plains, two regions where long-term unemployment was not widespread in the late 1950's [14]. In the industrialized eastern half of the country depressed local labor markets contributed significantly to low incomes of white rural farm people. Slack local labor markets were important also in the Intermountain region.

The sign of the coefficient on the value of farmland and buildings per farm worker was expected to be positive. Only in region VIII, the Southeast, was the sign of the coefficient negative, and in this region the coefficient was close to zero.⁶ In the Northeastern region (II), the Central and Southwest Plains (VI, X), and the Intermountain (XI) and Pacific Northwest (XII) regions, the value of farmland and buildings per farm worker was an important contributor to intercounty variations in the per capita income of white rural farm people. In these regions this ratio may be an adequate proxy for the capital—labor ratio in farming. This variable was significant but of less importance in the Lower Great Lakes (III), the Corn Belt (V), and the Central and Eastern Upland (VII) regions.

Proximity to SMSA's.—Proximity to SMSA's represents the effects of industrial—urban growth on per capita incomes in surrounding and outlying communities. These effects were hypothesized to be positively re-

⁵ The results for the Pacific Northwest (XII) are consistent with those of Sisler, whose data were for 1949-50 [10].

⁶ In this region (VIII) the ratio is made up of capital, owned mostly by whites, and white and nonwhite labor. This may explain a zero or negative coefficient in the "white" equation and a positive coefficient in the "nonwhite" equation.

lated to the distance between the county and the SMSA's. The sign of the coefficient of the proximity variable, therefore, was expected to be positive.

This expectation was realized in all regions. However, the coefficient was significant only in regions II, III, V, VII, and VIII, and in the Pacific Northwest region. All these regions except the last comprise or are adjacent to the Industrial Belt. Proximity to SMSA's was not significant in the Atlantic Metropolitan Belt or in the Upper Great Lakes region. The former region approximates one huge SMSA, allowing very little variation in the proximity variable. There was little variation in the Atlantic and Gulf Coast region, where proximity also might be expected to have some effect. In the Upper Great Lakes region (IV), local industrial-urban development has a positive influence on rural income levels but proximity to large centers appears to have little or no effect. Large areas in the region have forest cover. Mining and forestry are quite important in some areas. And the agriculture is an extensive type of dairying. Elsewhere in the country, with the exception of the Pacific Northwest, proximity to SMSA's has little or no effect on white rural farm income levels.

The nonwhite results

The demographic characteristics of nonwhite rural farm people stand out in sharp relief as the most important determinants of their per capita income in the four southern regions. In contrast to the white results, the coefficient of mean age is positive and significant in all but the South Atlantic and Gulf Coast region. For nonwhites the correlation between mean age and the percentage 45 years of age and over was lower than for whites. In the case of nonwhite rural farm people, therefore, mean age tended to reflect their average productivity and experience, rather than the prevalence of elderly people as it did for the white rural farm population.

Except in the Southwestern Plains (X), average education was the most important variable. In this region, mean age and education were highly correlated. Age, therefore, probably picked up part of the effect of mean education. The third moment of education was unimportant in determining nonwhite rural farm income levels. Also, the effect of mean education on nonwhite income levels is less than half the effect on white income levels, reflecting the effects of poor quality schooling and discrimination in the labor market [15].

Because earlier work had indicated the importance of employed females in the nonwhite population, the percentage of nonwhite rural farm females employed in 1960 was included in the nonwhite equations [1]. In each of the four regions this variable had the expected positive sign and was the second most important variable in the equation.

Except in the Southeast (region VIII) few of the other variables had coefficients significantly different from zero. However, this region is where most of the nonwhite rural farm people are located. Both facets of industrial-urban development account for some of the variation in per capita income among counties. And long-term unemployment in a county lowers the nonwhite rural farm income level.

In brief, the demographic factors of age and education are the most important determinants of nonwhite rural farm income levels. Nonwhite female participation in the local labor market raises the income level of nonwhite rural farm people. The coefficients on both the education variables and the local industry structure variables reflect the fact that nonwhite rural farm people are restricted to the unskilled section of the labor market.

Conclusions

Several overall conclusions arise from these results:

1. The hypothesized relationships were much more successful in explaining the intercounty variations in per capita income of white than of nonwhite rural farm people.

2. For both white and nonwhite rural farm people, education was the single most important determinant of per capita income. Even so, the effect of education on white per capita income was more than twice its effect on nonwhite rural farm income levels.

3. A high proportion of white rural farm people aged 45 years and over depressed rural income levels in the Upper Great Lakes, the Central and Southwestern Plains, and the Central and Eastern Uplands. It is interesting to note that these regions encircle the Industrial Belt and have sustained heavy out-migration.

4. The conclusions of previous work on the industrial-urban development hypothesis have been confirmed and refined [2, 6, 7, 10, 11]. Local industrial-urban development and proximity to large centers of industrial-urban development both exert positive effects on rural farm income levels in and adjacent to the Industrial Belt. In the Plains and Intermountain regions neither of these effects was discernible. And it appears that the effects of industrial-urban development were somewhat less important determinants of nonwhite than of white rural farm income levels.

5. Depressed local labor markets as indicated by relatively widespread long-term unemployment exert a negative influence on rural farm income levels, especially in the Industrial Belt and in the Intermountain region.

6. Agriculture is of importance in determining the per capita income of white rural farm people in regions where agriculture is a generally prosperous and important segment of the economy.

Policy Implications

Several policy implications can be drawn from the above results and conclusions. First, an increase in the formal education of rural farm people will do much to raise their incomes. Such a program will raise the incomes of nonwhite rural farm people in the South very much less than it will raise the incomes of whites unless the education available to nonwhites is at least of equal quality and unless discrimination in the labor market is reduced.

Second, policies to induce industrial-urban development both locally and in large growth centers will raise rural farm income levels. But such policies will be most effective in the regions lying within or adjacent to the Industrial Belt. Again, inducements to industrial-urban growth will likely have less effect on nonwhite than on white rural farm income levels unless discrimination in labor markets is reduced. And programs to induce industrial-urban growth elsewhere in the country may be largely ineffective in raising rural farm income levels unless very large sums of money are devoted to the program. There is a little evidence in these results to suggest that area development programs seeking to improve agriculture, forestry, and mining to support these industries with improved services may be more effective than industrialization programs in the Plains and Intermountain regions.

Third, monetary-fiscal policy to maintain an adequate level of aggregate demand and minimize the incidence of long-term unemployment can help raise rural farm income levels [9]. But monetary-fiscal policy alone is not sufficient. The results of this study suggest that aggregate demand policies have differential regional impacts. Without other programs operating simultaneously, an increase in aggregate demand probably would be of most benefit to low-income rural areas in the Industrial Belt.

Fourth, in the Upper Great Lakes, Central and Southwestern Plains, and Central and Eastern Upland regions, a predominance of elderly rural farm people depresses per capita income. Education, area development, and monetary-fiscal policies would have little effect on the incomes of these people; transfer payment programs would be more appropriate.

Appendix

Variable Specification

The county is the unit of observation for each of the variables.

Y_1 is the per capita income in 1959 of white rural farm persons aged 14 years and over.

Y_2 is the per capita income in 1959 of nonwhite rural farm persons aged 14 years and over.

X_1 is the mean of the age distribution of the white rural farm population.

X_2 is the mean of the age distribution of the nonwhite rural farm population.

X_3 is the mean of the distribution of years of school completed for the white rural farm population aged 25 years and over.

X_4 is the mean of the distribution of years of school completed for the nonwhite rural farm population aged 25 years and over.

X_5 is the third moment of the distribution of years of school completed for the white rural farm population aged 25 years and over.

X_6 is the third moment of the distribution of the number of years of school completed for the nonwhite rural farm population aged 25 years and over.

X_7 is the percentage of total employed persons aged 14 years and over engaged in forestry, fisheries, and mining.

X_8 is the percentage of total employed persons aged 14 years and over engaged in manufacturing and construction.

X_9 is the percentage of total employed persons aged 14 years and over engaged in industries other than agriculture, forestry, fisheries, mining, manufacturing, and construction.

X_{10} is the percentage of total employed persons aged 14 years and over who worked 39 weeks or less in 1959.

X_{11} is the percentage of nonwhite rural farm females aged 14 years and over who worked in 1959.

X_{12} is the value in thousands of dollars of farmland and buildings per worker employed in farming.

X_{13} is the weighted sum of the populations of the Standard Metropolitan Statistical Areas (SMSA's) in millions within a 200-mile radius of the center of the county, where the weight is the inverse of the distance between the county and the SMSA.

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Discussion: Industrial-Urban Development and Rural Farm Income Levels

LUTHER G. TWEETEN

Shortcomings of theory and methodology have plagued area development research for decades. The paper by Bryant and O'Connor is an improvement, but it is weakened by the same old problems.

I shall first discuss the theory in their paper as evident in the variables chosen to explain farm income. I shall next suggest a redirection of research on rural poverty and area development.

Theory

The authors assume in Table 1 that farm income per capita is a linear function of mean age. I have examined graphs of farm income per worker plotted against age at a given education level. These plottings reveal in all education categories that income rises to about age 45 and then declines. The relationship is somewhat symmetric around age 45 and is clearly nonlinear. A linear fit of income data to the age data corrected for education would reveal a coefficient near zero for a group with a median age of 45. Since the median age of farmers is about 51, "theory" would suggest a zero or slightly negative coefficient rather than the positive association posited by the authors. The authors could have improved their results by use of another variable for mean age: say mean age squared, or percentage of persons in the productive age category.

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The authors use the mean years of education to measure the contribution of education to income. But a year of education means one thing for whites in poverty areas and quite another for whites in prosperous areas. According to the authors, the impact of education on per capita rural farm income is more than twice as large for whites as for nonwhites. This finding suggests that the marginal return from educating whites is twice that from educating nonwhites and that the efficient use of the next education dollar is investment in white education. Data on rates of return do not support this conclusion.

The authors say that income per capita is a function of the percentage of primary, secondary, or tertiary employment in an area. This hypothesis is very mildly supported. But does it mean that the way to increase farm income is to raise the percentage of primary, secondary, or tertiary industry? If these are viewed as instrumental variables of public policy, one should examine the feasibility and cost-effectiveness of the approach. If these are viewed as noninstrumental variables and are included only as correction factors in the covariance framework, one should be concerned with what normal market forces give rise to the distribution of industry.

The authors say that per capita income is determined by the percentage of persons working 39 weeks or less in 1959. But are not these income and employment variables both a function of third factors, such as education, degree of mobility, race, and changes in demand for products of a region? Mobility of farm workers is a crucial variable determined by attitudes, past adjustments, education, and other factors. Yet mobility is given little explicit attention by the authors as a factor determining farm income.

The authors say that per capita income is determined by the value of farmland and buildings per worker. This goes some distance toward using as an independent variable that which the authors are trying to explain in their regression. Does the value of farmland and buildings per worker determine farm income or vice versa? Research has shown that a good case can be made for the latter [1, Chap. 12]. Perhaps the insight gained from the coefficients of the variable led the authors to conclude that "agriculture is of importance in determining the per capita income of white rural farm people in regions where agriculture is a generally prosperous and important segment of the economy." Few would argue with that.

The use of investment to explain income is a convenient shortcut, used frequently in area development analysis. But in this and other instances, we are interested in primary and secondary causes rather than tertiary causes. For the causes of investment, we must look to the natural resources, attitudes, institutions, and population density of an area.

The final variable is proximity to SMSA's. The authors find it is significantly associated with farm income in only 6 of the 13 regions. The coeffi-

cient ranges from 17 to 587. My views on these coefficients can be interpreted from the following comments on methodology.

Philosophy and Methodology

Research on area development has been hampered by undue preoccupation with urban industrialization as a solution to problems of lagging farm income. This is apparent in the title and early discussion of theory in the authors' paper. Not that I have any quarrel with the matrix location theory. It is as valid as the almost universally accepted classical precepts of mass economic behavior on which it rests. No wonder then our bewilderment and commitment to repeated testing when data frequently do not support the theory, including the authors' data in 7 of 13 regions!

It is inconceivable that the farm economy is not helped by more jobs and demand in urban centers—and the closer those jobs the better. But, although I believe this conclusion holds in all cases, it must be recognized that it is a very partial theory. The reason for negative empirical results is that other more important factors often overshadow the matrix location "theory." Is it not time that we began to analyze more deeply these other factors? One of the most prominent of these factors is the emphasis on education and training in an area [2]. Education and training are often preconditions for successful efforts to raise farm income through out-migration, industrialization, or more efficient output of crops and livestock.

Preoccupation with industrialization is also apparent in behavior of local areas which have established thousands of development corporations to attract industry. I do not mean to imply that preoccupation of economists with this theory has led to preoccupation of local areas with industrialization. Fortunately, economists have not had that much influence.

A useful point of departure to improve our policy prescriptions is the principle of cost-effectiveness, that is, which programs go farthest to raise incomes of people in low-income rural areas? Such an approach can help to establish priorities for ameliorative programs. Benefit-cost ratios of programs will differ among areas. For example, an area that has lagged badly in education will likely find returns to investment in education and training higher than returns to investment in enticing industry as a means to improve income and living standards. By this measure, contrary to Bryant and O'Connor's conclusion, public funds might most profitably focus on bringing industry to the Plains and education to the Southeast.

The approach which I have suggested would require numerous feasibility studies. Some progress is being made. But since the advent of considerable research on rural poverty about a decade ago, studies have largely been concerned with documenting the dimensions of poverty. It is time we moved beyond this stage and began to examine analytically the cost-effectiveness of the numerous public policies that can conceivably

be used to raise incomes in low-income areas. The day of a guaranteed annual income to raise income of all to a socially acceptable threshold level through a negative income tax or other transfer payment may arrive in a decade. Meanwhile, America appears to lack either the means or the will to eliminate poverty in this manner. Until poverty is annihilated by a guaranteed annual income, economists can usefully contribute to public policy by showing how the obviously limited public funds can go farthest to lift incomes of the poor. I submit that the cost-effectiveness approach is a useful beginning point.

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EDITOR'S NOTE: This section of the *American Journal of Agricultural Economics* may include comments on and replies to previous articles and other literature in agricultural economics, suggestions for improving the effectiveness of the AAEA, discussions of changes in emphasis needed within the profession, and contributions on other topics of interest and importance to agricultural economists. Manuscripts submitted for this section should be prepared in accordance with the guide appearing on the inside of the back cover of this issue and should not exceed 1,000 words.

Communications

"REALIZED" FARM INCOME: AN OUTMODED CONCEPT? COMMENT*

A statistical series—realized net farm income—was apprehended, indicted and hailed before the bar in the November 1967 issue of this journal [1]. The article reads like a statement for the prosecution. This comment is a brief for the defense.

The defense contends that the defendant was apprehended illegally on a charge of confusing a Harvard economics professor. The alleged victim has testified that he was not confused.¹ Thus, there were no grounds for the arrest. We will assume that the defense is overruled on the question of the legality of the arrest.

The prosecution alleges that "total" farm income is the only legitimate measure of farm income and that the very existence of "realized" farm income is a statistical felony that should

be punished by prompt extinction of the series.

The prosecution asserts that inventory change must be counted as income in the year in which the commodities are produced at the prices that prevailed in that year. It is further asserted that the value of change in inventory is in principle the same as an addition to or a withdrawal from savings. These savings are not held in dollars, however, but in commodities. And the prices at which they are sold may be either more or less than the price that was used in valuing the change in inventory. The defense asserts that realized net farm income, by valuing commodities at the prices at which they are actually sold, provides a valid measure of the income from farming that farmers have available to use or save. Realized net farm income is a useful measure in its own right, not an imitation of total net income.

The defense will first discuss charges 1, 3, and 4 individually and then turn to charges 2, 5, and 6.

Charge No. 1: The continuation of

* The views expressed here are the personal views of the author.

¹ This renders moot an interesting legal question, to wit: Is confusing a Harvard economics professor a crime anywhere except possibly in a few jurisdictions in Massachusetts?

the realized farm income concept along with the necessary total income concept causes unnecessary confusion among unsophisticated users of the data [1, p. 802].

Both realized and total income data are regularly published by USDA. Statements about farm income by USDA officials are based on the realized farm income series [2, p. 3]. However, it is the total farm income series that is given most attention by Commerce and the Council of Economic Advisers.

To this charge the defense pleads guilty, but with extenuating circumstances. On the basis of the record, a user could easily be confused by comparisons of revised with unrevised estimates, even though the realized farm income series had never existed. Some degree of confusion may be endemic to income statistics. Confusion can be reduced but probably not eliminated.

Charge No. 3: The availability of realized income data along with total income data provides a most undesirable choice of statistical series to the more sophisticated users of the data [1, p. 802].

The defense moves to dismiss this charge on the grounds that the prosecution has introduced no evidence that a crime has been committed or identified an offender.

Charge No. 4: Realized income is probably estimated less reliably than total income [1, p. 802].

The defense cites the use of the word "probably" in the charge itself and contends that the charge is unproven.

In support of the charge, the prosecution states that "the inventory change is thus a residual, derived as the difference between estimated sales plus home consumption and the latest

report on total production. If we assume that total production is accurate as currently reported, an overestimation of sales will automatically be compensated for by an underestimation of inventory change and vice versa" [1, p. 800].

The prosecution neglected to mention that there are important exceptions to which this neat, self-correcting mechanism does not apply. Meat animals and feed crops are examples.

There are no current estimates of production of meat animals. Data on slaughter by months are available currently. These data provide the basis for current estimates of marketings of meat animals. Furthermore, the simple identity—marketings and home consumption plus change in inventory equals production—does not apply. Marketings of meat animals, particularly cattle and calves, exceed production. The reason for this is that some animals are marketed first as feeders and later as fed animals.

The relevant quantity for the total income concept for feed crops is not total production but total production minus use as feed and seed on farms where grown. On a crop-year basis, the value of sales of feed crops is something less than half the value of production. Thus, this is not an unimportant exception.

The defense asserts that the other three charges are based on a false premise. The charges are as follows:

Charge No. 2: The realized farm income series is contrary to generally accepted theory and practice of income measurement [1, p. 802].

Charge No. 5: It has omitted significant amounts of farm income from an official USDA series, especially in recent years [1, p. 802].

Charge No. 6: It has resulted in sub-

stantial, unrealistic, and unjustifiable smoothing of the farm income estimates [1, p. 802].

The false premise is that there can be one and only one true measure of farm income, namely total income, and that to the extent that realized income differs from total, it is guilty. The defense accepts the point that total farm income is the key farm income concept but asserts that in the complicated world in which we live there is need for more than one farm income series.

On this point the defense calls the prosecutor himself as a witness. The prosecutor points with approbation to "purely cash income" [1, p. 804]. This series would certainly be guilty of charges 2 and 5, and yet, far from being in the dock with the accused, it is paraded by the prosecution as a repository of virtue.

Since these charges are based on a false premise, the defense moves that they be dismissed as irrelevant and immaterial.

To sum up, the defense contends that only one charge—contributing to the confusion of unsophisticated users—has been proven. The defense further contends that this is at most a statistical misdemeanor, not a felony.

The sentence for this misdemeanor should be no more than dismissal from its present position of honor as the primary USDA measure of farm income and incarceration in the rear pages of the statistical section of the July issue of the *Farm Income Situation*. Any more severe sentence than this would be cruel and unusual punishment.

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"REALIZED" FARM INCOME: AN OUTMODED CONCEPT? COMMENT

As one who for years has defended the concept of "realized" farm income, I must take up the cudgels with respect to Ernest Grove's article calling for discontinuing the statistical series of that name [Ernest W. Grove, "‘Realized’ Farm Income: An Outmoded Concept?" *J. Farm Econ.* 49:795-805, Nov. 1967].

Grove wants to force all farm income data into a single mold, that of "total" income. His arguments range from the sound to the specious. As an

example of the latter, he says that "use of the word *total* is a dead giveaway in making a sound choice" [p. 798]. How convenient a tactic that could be in many arguments; the title would prove the point!

Grove favors reporting total income because, when an allowance is included for change in inventories during each year, total income comes closer than "realized" income to measuring annual physical product of agriculture. This reasoning is flawless,

and whenever data are sought for that purpose, the total series should be chosen.

But when the object is to reflect the welfare status of recipients of income, the horse's color changes. Then there comes to the fore the familiar contradiction that a buildup of physical inventory does not generate an equivalent delayed income to farmers. Because of the well-known inelasticity of farm-level demand, when the inventory is sold the depressing effect on current prices can wipe out much or all of the statistically calculated potential income—and dash farmers' hopes in the process.

Part of the trouble is that farmers and statisticians are addicted to constant-price images, despite the notorious inconstancy of actual prices. In the series for total income, the inventory for the beginning and close of the year is valued at the same price. By disregarding the inverse quantity-price relationship it distorts the income-producing potential of a change in inventory. Specifically, it overstates the income contribution of a net buildup at year's end and understates the income to be derived from a small closing inventory.

Take cattle, for example. When producers expand their inventory, holding more animals to be sold the next year, according to the total income concept an equivalent value for the added animals should be added to the current year's actual received income. To the uninitiated this might appear correct. But cattle prices are infamous for collapsing whenever the inventory is liquidated. Frequently, total revenue realized is not larger by virtue of the greater quantity sold, but smaller.

All of which illustrates once again the statistical implications of struc-

tural differences between industry and agriculture. Industry's administered pricing practice avoids many of the pitfalls just named. It lets physical data on inventory accumulation be translated directly into income, within tolerable limits of error. Agriculture's volatile and inelastic markets deny the convenience of doing the same thing with farm income data.

It might be supposed that as agriculture becomes more industrial in structure, output and income-received data will be more co-determinate. This is now the case only for products that are essentially priced at price support levels—provided the support prices themselves are not too flexible. To the extent that certain crop inventories have been sheltered from price inelasticity by this means, Grove's argument is correct.

But the present trend is to fix commodity prices less according to support prices. The overwhelming evidence is that more farm products will be subject to fluctuations in price and value than will be protected from them.

Moreover, another apparent trend is to set goals for farm policy more on the basis of comparisons of income than on the basis of price (tagged as "income parity rather than price parity"). Therefore, there will be more cause to compute and publish data that measure farmers' income position accurately.

Because "total" income overvalues the income-generating power of a large inventory of crops and livestock and undervalues a small one, it exaggerates year-to-year swings in income actually received. This is not a strength in the total income series, as Grove alleges, but a weakness, and the less erratic realized series is not to be deplored but welcomed. It is bad

enough that actual incomes received (realized) vary sharply from year to year. Why add a statistical exaggeration?

There thus is good cause to retain the realized income series. It properly includes allowances for nonmoney income, which is more truly income than is the chimera of overvalued inventory. The prescience of Oscar Stine and Louis Bean still deserves re-

spect. There is equal cause to continue to publish a total income series. Use "realized" data to measure income as such and "total" to report gross product produced.

It is nice to simplify, but it should not be done at the cost of forcing one series of data to do the work of two.

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"REALIZED" FARM INCOME: AN OUTMODED CONCEPT? REPLY*

Old error, deeply entrenched, dies hard. Emotions become involved in what should be a purely technical discussion. For example, I felt obliged, in the interest of conciliation, to put a question mark in the title even though I knew the correct answer all along! And I rounded up all the arguments¹ I could think of in my original article [2] in anticipation of the inevitable counterattack.

This has now come, but it is surprisingly mild and is, in my opinion, ineffectual. Randall revives the "purchasing power" argument, among others; and Breimyer bases his whole case on this hoary and shopworn notion. I discussed it in my article [2, p. 804], but apparently not very effectively. The first order of business,

therefore, must be to dispose of this argument once and for all.²

Breimyer introduces the argument by noting that "when the object is to reflect the welfare status of recipients of income . . . there comes to the fore the familiar contradiction that a buildup of physical inventory does not generate an equivalent delayed income to farmers." But a farmer with a barn full of grain is likely to feel just as well off as if he had sold the grain.³ In fact, he may feel *more* secure with a full barn than with a full purse. And this may be why many farmers turn themselves into speculators every year by holding commodities instead of dollars. At any rate, there is no good

* The author accepts sole responsibility for views expressed but acknowledges valuable technical assistance received from Edward F. Denison of The Brookings Institution and Milton Moss of the Office of Statistical Standards, Bureau of the Budget.

¹ Not all of these arguments were directed to the heart of the matter, but none was "specious."

² But before proceeding, I should cite one more objector. In a letter dated January 26, 1968, Dr. O. C. Stine of Shepherdstown, West Virginia, restated his original credo: "I now have in a feed bank and barn considerable volumes of corn and surplus hay from the 1967 crop. They are not income and/or purchasing power until sold—or fed and the products sold—in 1968. The prices or value will not be known until then."

³ Let us call O. C. Stine "the exception that proves the rule."

reason for downgrading a full barn (or a big herd) from a "welfare" standpoint.

A complete answer to the "purchasing power" argument must be given in terms of both theory and practice. The key to the former is the word "speculators," as used above. It is a basic axiom of income theory that product and income in total are always the same, although their breakdown may be quite different. But what, then, are changes in the value of existing commodities? Capital (or inventory) gains and losses, of course. And who reaps such gains or losses? Why, speculators, naturally—and that is what farmers are when they hold larger-than-needed inventories.⁴

Nonfarm corporations are well able to carry the risk of large inventories, and in eight of the last ten years they have enjoyed substantial inventory profits as a result of upward revaluations. But such profits are routinely removed from the estimates of national income and gross national product by means of the "inventory valuation adjustment" [1, p. 3].

There are futures markets for most important farm commodities—even including cattle, Breimyer's favorite example—so if any farmer really wishes to avoid the risk of inventory loss, *and* the chance of gain, he can sell "short" in the futures market for the commodity he considers himself to be currently too "long" on. Such "hedging" operations are available to farmers, though perhaps not very conveniently in most cases. As we shall see, however, the more likely conclusion is that farmers have become in-

veterate gamblers, at least partly as a result of their past experience in this inflationary economy of ours.

As static theory for a stationary state, Breimyer's views on cattle prices in relation to inventories cannot be faulted. But income is always both determined and measured in relation to the actual dynamics of the current situation. So let us take a look at the historical record for cattle during the last 30 years (1936–1965) for which necessary data are now available.

During 20 of those 30 years, the number of all cattle on farms increased [6, p. 363]; and so we should expect, according to Breimyer's postulate, that the price would have fallen in each of the succeeding years. But the average of prices received by farmers for beef cattle was down in only 9 instances, and was actually higher following 11 of the 20 years in which cattle numbers rose [5, p. 389; 6, p. 372]! Not only have cattle prices not "collapsed" *inevitably* after a year of inventory buildup; they have actually increased *more often* than they have decreased.⁵

Turning now to Randall's comment, he notes that the "alleged victim has testified that he was not confused" [3],⁶ and that the prosecution—

⁴ The series on costs and returns for typical farms, started by the USDA more than 30 years ago, have never given any recognition to the "realized" concept. The "change in inventory of crops and livestock" has always been counted in gross and net farm income for these series, which now include eight farms with cattle, not including dairy farms [7]. How could these data have been reported as "typical" for all these years if there were any substance to Breimyer's comment?

⁶ If the alleged victim was *not* victimized (confused), another question inevitably arises: Was he himself trying

⁴ This includes O. C. Stine, who should now recognize his new image as farmer-speculator as well as agricultural economist.

that's me—must therefore prove “that the very existence of ‘realized’ farm income is a statistical felony.” This I fully intended to do—and will now try to do again for good measure, by returning to a technical but nevertheless important consideration that was mentioned in the article but apparently was not sufficiently emphasized.

This is the discrepancy between gross income and expenses deducted [2, p. 800]. “Realized” net income may include, on the receipts side, proceeds from a decrease in inventories of the *preceding year*; but on the cost side it may also include costs of an increase in inventories of the *current year*. To say the least, it is an extremely fuzzy accounting procedure.

This is really the heart of the matter, and it constitutes a *fatal* flaw in “realized” farm income, so it bears repetition and stronger wording. To subtract the expenses incurred in producing the value of one quantity of output—in this case, that produced in a year—from the value of a different quantity of output—in this case, that sold or consumed in the year, regardless of when it was produced—cannot possibly yield a residual that corresponds to any known income concept. In fact, being wholly without meaning, this residual is a *statistical nonsense series*.

to victimize (confuse) the public by falsely citing two authorities instead of one, not just once but several times, in an article [4] which he has admitted [3] was intended for a popular and unsophisticated audience?

As the defense attorney, Randall has built his case on some truth (on reliability of estimation), some half-truth (in questioning my reference to “purely cash income”¹), and the rest mostly sophistry. But his whole case collapses in the face of this new indictment. The best verdict on the “realized” income concept that he can hope for is “not guilty by reason of insanity”!

I might be willing to accept such a verdict provided that it was clearly understood, by the defense as well as the prosecution, that the defendant—who, whether criminal or not, has been clearly demonstrated to be dangerous—must be put away in an institution of maximum security for the rest of his unnatural life. Back pages of the *July Farm Income Situation* are not secure enough. Some inaccessible file of the ERS Farm Income Branch would be acceptable—or, better still, the Agricultural History Branch. As I said before, it is time to put “realized” farm income in Clio’s lap and let *her* be the judge.

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¹ Randall’s questioning is correct, but for the wrong reason. Net cash income suffers from the same fatal flaw as “realized” net income because it subtracts all production expenses, including those incurred for the production of home-consumed farm products, as well as any increase in inventories, from “purely cash income.” So I should not have referred to the latter as I did. It would probably be useful in a flow-of-funds analysis; but it is not a suitable measure of income or product.

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EVALUATING RECREATION BENEFITS FROM VISITATION PREDICTION EQUATIONS: COMMENT

A number of equations derived by multiple regression techniques for predicting reservoir recreation visitation have appeared in the literature [1, 2, 3]. The authors of these have suggested that recreation benefits be estimated by using the derived equations to relate travel distance to visitation and converting the disutility of overcoming distance into money units. Three aspects of the process have not been adequately developed and deserve comment.

The equation of best fit for estimating recreation visitation differs from the equation of best fit for evaluating recreation benefit. A visitation-based regression minimizes the sum of the squares of the deviations of recorded from predicted visits, by visitation center. However, use of the resulting equation to estimate benefits requires converting distance to money units and thus produces a greater benefit per visitor from more distant locations. Errors in visitation prediction from more distant centers thus affect benefits more than do errors in visitation prediction from closer centers. Benefit estimation can be improved by providing in the regression for the variation in unit benefit.

Second, the unit value needed to convert distance into money units is

the cost per mile per visitor-day spent at the site. This is not the same as the widely used marginal operating cost per vehicle-mile because it does not incorporate round trips, groups of visitors riding in the same vehicle and spending several days at the site, the value of traveling time, and a number of other important factors. A more realistic equation for the conversion would have the form

(1) $C = 2r[(1 + a)m + t/v]/bp$,
where C is the cost per mile in dollars per visitor-day spent at the site, 2 accounts for round trips, r is the ratio of road to the air distance usually found in prediction equations, a is the expense incurred for food and lodging above that spent at home expressed as a fraction of vehicle operating cost, m is the variable vehicle operating cost in dollars per mile, t is the value of a vehicle-hour of traveling time in dollars, v is the mean vehicle velocity in miles per hour, b is the number of days visitors remain at the site, and p is the number of visitors per vehicle. Published data are available for evaluating most of these terms [4, pp. 128–130]. Substitution in equation (1) of typical values of 1.21 for r , 0.5 for a , 0.053 for m , 1.50 for t , 40 for v , 2.27 for b , and 3.67 for p gives a value of C equal to \$0.034 per mile

per visitor-day. This contrasts with the \$0.053 per mile where m alone is used. A more refined analysis would vary C with distance traveled, because a , b , and especially p increase with the distance the visiting party is from home.

Third, the unit cost of equation (1) should not be applied to the total travel distance from the home of the visitor to the reservoir. In order to estimate the recreation benefit marginal to a particular reservoir—the information needed for economic evaluation—one should apply the unit cost only to the distance the visitor goes out of his way to reach the site. For most of the visitors living nearby, out-of-the-way dis-

tance will equal total distance. For the average visitor living several thousand miles away, out-of-the-way distance will equal a small fraction of total distance. Because no published information was available for evaluating out-of-the-way distance, postcard questionnaires were recently distributed to visitors to Dewey and Rough River reservoirs in Kentucky [4, pp. 72–80]. Each visiting party was asked how far the members lived from the reservoir (D) and how far they traveled out of their way for their current visit (ΔD). The resulting variation of $\Delta D/D$ as a function of D is shown by the line plotted in Figure 1. The ratio was found to be 1.0 for visitors living closer

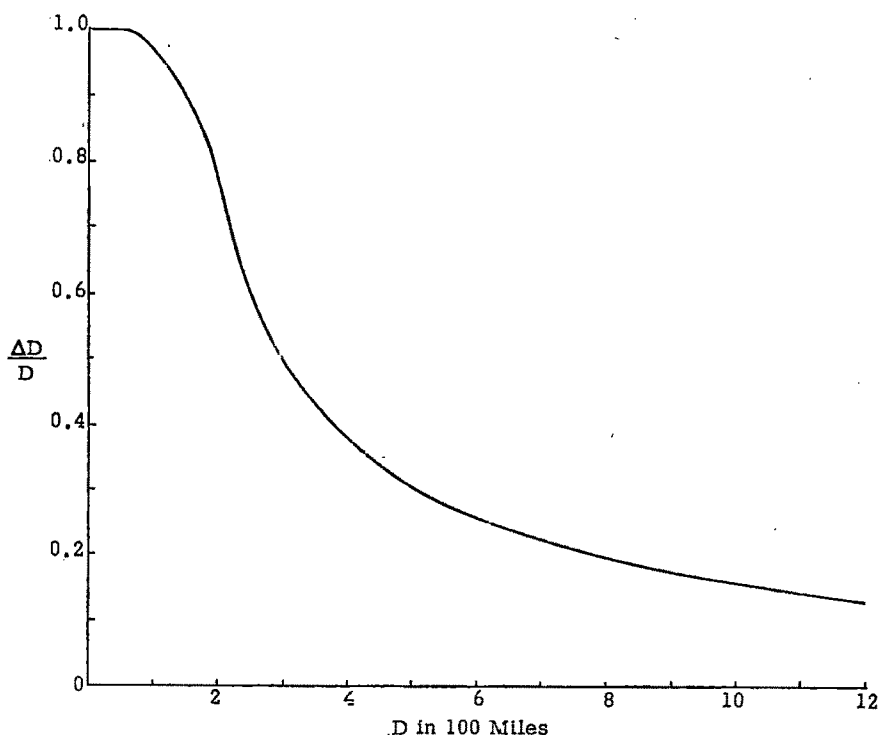


Figure 1. Effective fraction of total distance, as measured by the ratio of out-of-the-way distance to total distance traveled to the recreation area

than 50 miles while ΔD was found to remain constant at 150 miles for those living more than 200 miles away. Of course, each point represents an average for a large number of visitors and may not apply to any particular visitor.

These three refinements should help to improve benefit evaluation from reservoir recreation visitation equations. An equation developed for the

purpose of benefit estimation will work better than one derived for another purpose. The correct units should be maintained in converting distance to cost per visitor-day spent at the site. Marginal rather than total travel distances should be used.

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EVALUATING RECREATION BENEFITS FROM VISITATION PREDICTION EQUATIONS: REPLY

The first issue raised by James pertains to errors in estimating visitation rates from distant places. For prediction purposes, which were our concern, the main need is to estimate visits from the close distances where most visits originate. In contrast, James's concern is that errors in visitation rates from distant places affect benefit estimates based on the consumer surplus method. If benefits of a park are estimated by use of constant elasticity demand functions like those in the first part of our 1966 article, the yearly benefits are

$$\sum_i N_i \int_{D=D_i}^{D=D_M} m a_i D_i^b dD.$$

The distance to the park from the i th area is D_i , and D_M is the maximum distance from which there are visitors. The per capita recreation demand function is $m a_i D_i^b$, where m is value per mile

and a_i reflects the influence of variables other than distance. The integral is the consumer surplus per capita for the area. Total benefits are obtained by multiplying benefits per capita by area population (N_i) and summing over all areas.

Relative variation in visitation rates, which provides the basis for estimating the constant elasticity per capita demand function, is likely to be greater for more distant areas than for closer ones because visits from distant areas are small in absolute terms. Thus, a problem associated with visitation rates from distant areas is that heteroscedasticity may be introduced, undermining the theoretical basis for the regression. In a regression of per capita visitation rates on various independent variables, a visitor from a distant center has more weight than one from a near center because he is one of a small number

determining the visitation rate for the place from which he comes. These related phenomena of heteroscedasticity and unequal weight of visitors affect the reliability of the estimated elasticity b . In computing park benefits from a constant elasticity function, distant visitors are of concern because they raise statistical reliability problems, not because there is a greater benefit per visitor from distant locations.

Alternatively, suppose that distance zones are used without imposing a functional form. This was the approach in the latter part of our article. Then the benefits of the park would be estimated as

$$\sum_{i=1}^{i=M} N_i \sum_{j=i+1}^{j=M} Z_j,$$

where Z_j is visitation rate from the j th zone times the width of the zone times the value per mile. The right-hand summation gives the value of the amount of traveling per capita which people in the i th zone would be willing to do to visit the park, which they do not have to do, based on the observations of the amount of traveling which people from greater distances are observed to do. These benefits per capita are multiplied by population N_i to obtain benefits of visits from the i th zone. Total benefits of the park are then the sum of the benefits over all distance zones. Rearrangement of the expression gives

$$\sum_{i=1}^{i=M} Z_i \sum_{j=i-1}^{j=i-1} N_j.$$

The term

$$Z_i \sum_{j=1}^{j=i-1} N_j$$

for a particular value of i gives the contribution to total benefits of the visitation rate from the i th distance zone. The visitation rate is weighted by popu-

lation living closer to the park. As one goes to more distant zones, the

$$\sum_{j=1}^{j=i-1} N_j$$

effect becomes greater; that is, the more distant the center, the greater is the population weight by which the visitation rate is multiplied. However, another effect in considering more distant centers is that the visitation rate becomes smaller. Only if the expanding N effect exceeds the diminishing Z effect will the contribution to total benefits become greater as one considers more distant centers.

Consider the

$$Z_i \sum_{j=1}^{j=i-1} N_j$$

terms when population is uniformly distributed and the width of the distance zones is equal for all the zones. Then N_j equals $2\pi v_j w_j D_j$ where v_j is the density of population.¹ For bench-mark purposes, consider how the visitation rates would vary if the elasticity with respect to distance were -2 . This is a realistic order of magnitude and happens to be the elasticity which implies the $Z_i \sum N_j$ terms approach a finite nonzero asymptote. If the absolute value of b is less than 2, the contributions to the benefit estimate become progressively larger; they approach zero if the absolute value of b is greater than 2. Let distance be measured in units of width of distance zone, a procedure which implies that $W=1$ and $D_j=j$. Then, substituting kD_j^b for Z_i and $2\pi w D_j$ for N_j into

$$Z_i \sum_{j=1}^{j=i-1} N_j$$

¹ If D_j is the distance from the park to the middle of the j th zone, the population living either within the j th zone or closer to the park is $\pi(D_j + \frac{1}{2}w)^2$. The population living closer than the j th zone is $\pi(D_j - \frac{1}{2}w)^2$. Subtraction gives the result just stated in the text.

and making use of the fact that

$$\sum_{j=1}^{i-1} j$$

equals $i(i-1)/2$ leads to the result that the contribution of the visitation rate from the i th zone when $b=-2$ is $\Pi v'k(1-1/i)$. The expression in parenthesis, $1-1/i$, determines the relative contribution of the i th zone to estimate of park benefits. The value of $1-1/i$ rises gradually from 0.5 for the second distance zone toward its asymptotic value of 1. A tentative generalization is that the contribution of the zones at most of the different distances included in an analysis may be of about the same order of magnitude. Eventually, the elasticity in reality must become zero, so that distance zones beyond a maximum range will be excluded.

Now suppose that population is not distributed in uniform density. If v' is the average of population densities for all the distance zones included, the population nearer to the park than the i th zone is

$$2\Pi v'w \left[E_i + \sum_{j=1}^{i-1} D_j \right],$$

where E_i is the effect of the excess or deficit of population nearer than the i th zone because of uneven distribution of population. If e_j is the percentage by which actual population exceeds the population that would be observed if density in the j th zone were average, then²

$$E_i = \sum_{j=1}^{i-1} e_j D_j.$$

² The population nearer than the i th zone to the park is

$$\sum_{j=1}^{i-1} 2\Pi w v_j D_j.$$

Since $v_j = v' / [1 + (v_j - v')/v']$ and $e_j = (v_j - v')/v'$, the population nearer can be written as

Using the new expression for population closer to the park to evaluate

$$Z_i = \sum_{j=1}^{i-1} N_j$$

by the same procedure as before, again supposing $b=-2$, we find that the contribution to the benefit estimate of visitation from the i th zone is

$$\Pi v'k \left(1 - \frac{1}{i} + \frac{2E_i}{i^2} \right).$$

Consider the effect if there were in the third zone a population concentration twice as great as elsewhere. Then for $i=1, 2, 3$, the

$$Z_i = \sum_{j=1}^{i-1} N_j$$

term is, as before, $\Pi v'k(1-1/i)$, but for i greater than 3, the term is

$$\Pi v'k \left(1 - \frac{1}{i} + \frac{6}{i^2} \right).$$

The visitation rates just beyond the third zone have the greatest weight in determining total benefit, their weights being greater than those of any more distant zones that would be included even if the park drew visitors from an infinite distance. For many parks, a nearby metropolitan center dominates visitation and would make the counterpart to e_3 larger than assumed here. The example suggests that highly important zones are those which are just slightly more distant from the park than the zones containing large population concentrations. Those slightly more distant zones give the main indication of how much farther visitors from the population concentrations would be willing to travel.³

$$2\Pi v'w \sum_{j=1}^{i-1} (D_j + e_j D_j),$$

which can be seen to be equivalent to the result in the text.

³ The first line of the three given below is

The second issue discussed by James is how to value cost per mile. In the regressions of our study, distance is a proxy for price, implying that the cost of a visit is proportional to distance traveled. If the distance variable were converted to monetary units by multiplying by different values per mile, the resulting demand functions would have the same coefficient for price as for distance. Only the constant term of the equation would be affected. Because of the difference in constant terms, the benefit estimate would be changed, but the predicted number of visits would be the same.

In the measure of cost per mile suggested by James, which we agree is preferable in most respects to one-way vehicle-operating costs, number of visitor-days spent at the site is used as a divisor to obtain cost per mile per visitor-day. An issue is whether visitors who stay different numbers of days should be lumped together in the same demand curve. Since multi-day visitors have a different recreation experience from one-day visitors, the best procedure may be to estimate different demand curves for different types of visitors. The total demand is then the sum of these different demands. In the study of a facility, explicit consideration could be given to how much refinement of this type is worthwhile and how much distortion is likely if one compromises

by lumping different types of recreation experiences together.

We agree with the third point made by James, that the appropriate distance in studying recreation demand is out-of-the-way distance. Using distance to place of residence instead of out-of-the-way distance, however, may introduce only minor error in visitation prediction, because for the majority of visitors the two concepts are identical and because the tourist traffic which generates out-of-the-way distance from a longer trip will tend to grow in proportion to the population of the tourists' place of residence.

For estimating benefits of visits for which travel is out of the way from a longer trip, an alternative to the procedure suggested by James is as follows: Identify major routes from which diversion occurs and compute the visitation rate by taking the number of tourists who were diverted from each route dividing by total tourist traffic on the route. The different routes provide observations from which to estimate a relation between proportion diverted and out-of-the-way distance.

The list of refinements needed in estimating demand for a recreation facility should be extended. In addition to effects of competing facilities and crowding, mentioned in our 1966 article, effects on quality of the recreation experience due to unique features of a facility deserve attention. One approach is to develop measures of quality as a demand shifter, whose effect can be estimated by comparing visitation rates to different reservoirs. If a functional form is to be imposed, experimentation with different forms is needed. The cell analysis in our article leads to doubt

distance zone i . The second line is $(1 - 1/i)$, allowing comparison of contributions to benefit estimate according to distance if population is evenly distributed among zones. The third line allows comparisons if the population in the third zone is twice as great as in all other zones; the first three terms in the third line are $(1 - 1/i)$ and the remaining terms are $[1 - (1/i) + (6/i^2)]$:

1	2	3	4	5	6	7	8	9	10	...	15	...
0	0.50	0.66	0.75	0.80	0.83	0.86	0.87	0.89	0.90	...	0.93	...
0	0.50	0.66	1.12	1.04	1.00	0.98	0.97	0.96	0.96	...	0.96	...

about whether the true visit-distance relation is consistent with a constant elasticity form. Most recreation demand estimates have been for public-access use. Although land-value increments due to the use of private access from cottages and homes have been estimated,

the further step of estimating private access benefits needs to be taken.

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THE PRICING OF EGGS: A PROBLEM?

A large literature has developed with respect to the "egg pricing problem" [e.g., 1, 2]. However, in most cases, a precise definition of a problem is not given, and there is a tendency to jump from an alleged problem to proposed solutions without demonstrating the existence of a problem.

Price performance may be measured by the average price, by the frequency of price change, and by the magnitude of price changes. Egg prices have been alleged to be "too low," to fluctuate "too frequently," and to fluctuate "excessively." Observers, then, usually suggest that the source of these problems is the egg pricing mechanism, which is based on central market quotations. This mechanism is thought to be inappropriate because central markets no longer account for a large proportion of total egg transactions.

Two questions may be raised with respect to the allegations. First, are they valid, and is there a problem? We argue that the evidence is far from clear and that much work remains to be done simply in terms of problem definition. Second, if price performance problems do exist, what are the sources? Critics have concentrated on the institutional arrangement for pricing. In discussing the

general topic of price performance, economists concentrate on economic forces and market structure. We briefly outline some of these alternate sources of "unsatisfactory" prices. In addition, this communication considers some aspects of evaluating pricing mechanisms, a topic which has received relatively little treatment by economists.

With respect to problem definition, an examination of data from the New York City wholesale market indicates that egg prices changed an average of 66 times per year from 1910 to 1914, 123 times from 1950 to 1954, and 114 times from 1960 to 1964, with an average of 250 trading days in each period.¹ Thus, prices do change more frequently now than 50 years ago, but price changes have been slightly less frequent in the 1960's than in the 1950's [2, p. 40]. Using daily price quotations for large white eggs, we computed [2, p. 35] the statistical measures shown in Table 1. Currently there is much less price variability for eggs than there was 50 years ago. However, these results must be interpreted within the context of a great

¹ A price change is defined as a change in the central market price quotation. Only one price is quoted daily for each egg class on the New York market. Each time that the quotation differs from its previous level constitutes a price change.

Table 1. Statistical measures of prices for large white eggs, 1910-1964

Years	Average price	Standard deviation	Coefficient of variation
	.....cents per dozen.....		percent
1910-1914	35.58	11.34	31.9
1950-1954	54.12	8.89	16.4
1960-1964	39.07	5.87	15.0

decline in the seasonality of egg production and prices.

These data do not demonstrate the lack of a problem; they do suggest the difficulty of defining one. The evidence indicates, for example, that price variability has declined with present pricing arrangements, but it is still possible to hypothesize that a change in pricing mechanisms would further reduce price variability.

If we assume that price performance is unsatisfactory, what are the possible sources of the problem? Traditional price theory is, of course, one source of hypotheses. The average level of egg prices, which may be too low from the viewpoint of producers, appears to be related mainly to basic economic factors rather than to the pricing mechanism. The demand for eggs declined in the 1950's. There have been substantial improvements in the technology of production, implying lower unit costs and increases in supply.

The frequency of change in economic factors helps to explain the frequency of price changes. The magnitude of price changes may be related to the magnitude of changes in economic factors and to the size of the relevant elasticities. Seasonality in production and perhaps in the demand for eggs provides a partial explanation for the frequency and magnitude of price changes within a season. Holbrook Working has provided

a model with respect to short-time commodity price variations [3]. He emphasizes that prices are discovered under the influence of expectation by traders about economic forces. Thus, changing information and perhaps changing evaluation of available information may change prices.

In sum, price theory would seem to provide a basis for evaluating price performance. Low prices, large price changes, or frequent price changes may very well be consistent with the underlying factors influencing prices. Still, much of the criticism is based on the alleged inadequacies of the egg pricing mechanism. Perhaps economists should devote more research effort to the economics of pricing arrangements.

The performance of price and of pricing mechanisms must be analyzed relative to changes in economic forces and to the expected roles of price. A particular pricing arrangement could be appraised, in part, on the basis of its economic efficiency in discovering prices consistent with existing economic forces. However, appraisal of a pricing mechanism requires more than an analysis of its ability to discover market-clearing prices. There are questions, for example, of the role of prices in allocating the commodity regionally, in determining future supplies, and in determining the distribution of income. Thus, research on pricing mechanisms requires an analysis

both of the "benefits" of the various roles price is expected to play under alternative mechanisms and of the "costs" of obtaining these benefits by the use of the various mechanisms.²

To illustrate these points, we might hypothesize that the present quotation pricing system for eggs is the lowest-cost alternative for discovering prices but that this system results in price changes which are too frequent relative to the market-clearing or re-

source-allocating roles of prices. If the hypothesis is true, then alternative pricing systems (e.g., pricing on the basis of a committee decision or by formula [2, pp. 57-70]) which will provide the benefit of a more stable price though at a higher cost are presumably available. Without further quantification, we could not say which alternative is best in an economic sense.

This viewpoint can be summarized with three questions. Is there an egg pricing problem? If so, does it result from the present pricing mechanism? If it does, how do we evaluate alternate pricing mechanisms to determine a preferred alternative?

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² Clearly, the quantification of benefits and costs would be difficult. Benefits would depend on the roles that prices are expected to play, the weights placed on the various roles, and an appraisal of how well alternate mechanisms achieved these roles. Costs would depend on the definition and inclusion of both monetary and nonmonetary items. While the difficulties of evaluation may be great, a method of evaluation should be considered.

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REGRESSION ANALYSIS WITH A LIMITED DEPENDENT VARIABLE*

Padberg and others [3, 4, 5, 6] have presented models, using simple linear regression, to analyze brand preferences. This communication comments on the applicability of the classical least-squares procedures to brand preference and to similar models.

* D. I. Padberg, B. F. Stanton, and an unknown reviewer provided helpful comments.

There are at least two alternative methods of specifying the brand preference model [5 or 6], but they have in common the simple linear regression equation

$$(1) \quad Y_i = \alpha + \beta X_i + e_i,$$

where

Y_i is total brand sales (say, of Brand A) as a percentage of total product sales, and

X_i is display space devoted to a brand (say, Brand A) as a percentage of the total product display space.

The specification of the model has several features of interest to this discussion. First, the purchasers may be divided into two groups: those with a brand preference and those without one. Purchasers without a preference are assumed to make brand selections at random, and hence their purchases of a particular brand should vary directly with the proportion of shelf space devoted to the brand (that is, X_i). The observed purchases of a brand will depend on selections made by preference and by random selection. This, in effect, is an experiment in which the proportion of shelf space devoted to a particular brand may be controlled and the resulting purchases observed.¹ As a consequence, the error term of the equation has a binomial distribution and the variance of the error term varies with X_i (that is, it is heteroscedastic).² These properties have been formally developed elsewhere [1].

The classical least-squares estimates of α and β would be unbiased although they would no longer have minimum variances. The classical estimators of the variance of regression and of the variances of the estimated coefficients would be biased [2, pp. 238-239], and the hypothesis testing procedures based on these statistics would be inappropriate.

Since heteroscedasticity is not uncommon, several other estimation methods have been proposed, including Aitken's generalized least squares. A formula for the variances of the esti-

mated coefficients is available [8]. For the brand preference type of problem, Beetle [1, pp. 8-9] proposes a simple method for conducting the experiment and hence for estimating α , β , and their variances: Select only two levels of X_i , which represent the assumed minimum and maximum of the range of linearity. With five "facings" for two brands, the minimum space devoted to one brand would be 20 percent and the maximum 80 percent. Let X_1 be the minimum level of shelf space, Y_1 the observed proportion of sales of the brand at shelf-space level X_1 , and T_1 the number of observations used in computing Y_1 ,³ and let X_2 , Y_2 , and T_2 be the corresponding values at the maximum of the range of X_i . Then the appropriate computational formulas are

$$\hat{\beta} = \frac{Y_2 - Y_1}{X_2 - X_1}, \quad \hat{\alpha} = \frac{Y_1 X_2 - X_1 Y_2}{X_2 - X_1}$$

$$\text{and } \text{var}(\hat{\beta}) = \frac{(T_2 - 1)(Y_1 - Y_1^2) + (T_1 - 1)(Y_2 - Y_2^2)}{(T_1 - 1)(T_2 - 1)(X_2 - X_1)^2}$$

The estimates of α and β are asymptotically normal [1, p. 5], and it follows that an approximate test statistic for a hypothesis about β is

$$z = \frac{\hat{\beta} - \beta}{\sqrt{\text{var}(\hat{\beta})}}$$

The number of observations should be large for the approximation to hold.

A second feature of the model is that it represents a case in which the dependent variable is constrained within a certain range (zero to 100, inclusive). Thus, the method of least squares also may give biased estimates of α and β . Goldberger says, "The classical regression model appears to be inappropriate when the range of variation of the

¹ This experiment is analogous to sampling with replacement from a population with given proportions of colored balls.

² The variance of e_i will be zero when X_i is zero or 100 percent and will be at a maximum when X_i is 50 percent [1, p. 3].

³ Y_1 and Y_2 are in effect averages based on replications of the levels of X_1 and X_2 in the experiment.

regressand is inherently bounded and there is a concentration of the regressand at its bound" [2, p. 252]. Biased estimates of α and β are obtained if Y is bounded and the observations are concentrated at the bound. If Y has a bound, then the disturbances also have a bound. With a concentration of the observations at the bound, the assumption that the expected value of the disturbances is zero may not be true. The usual application of least squares minimizes the sum of squared vertical deviations and forces the sum of deviations to be zero. Thus, the estimate of α may be too large and the estimate of β may be too small.

The question of bounded and concentrated Y_i probably is not an important one in the cases examined by Padberg. The values of X_i are, perhaps, not less than 20 percent, which implies that the observed Y_i 's are not zero, that is, are not concentrated at the bound. This would be one of many examples in which the dependent variable is implicitly restricted but the restriction is of little or no consequence. However, we should be aware of the potential bias in using least squares with a bounded and concentrated dependent variable. There are

various methods of dealing with this problem, including the probit, Gompit, and Tobit models [2, pp. 250-255; 8].

A third question is whether logic may suggest constraints on one or more of the parameters. For example, theory may require that α equal zero, in which case the regression should be forced through the origin [7, p. 155]. One might argue for this approach in Padberg's model, since Y_i must be zero if X_i is zero. However, two brands must be displayed for the analysis to be meaningful [6, p. 727]; that is, $X_i=0$ is not meaningful. As a consequence, a linear projection of the line to the Y -axis may give a positive $\hat{\alpha}$ even though consumers cannot purchase the brand if it is not displayed. The researcher should build in the constraints implied by the theory, but he must be careful that the theory really requires the constraints.

In sum, researchers should remind themselves from time to time that statistical inference proceeds from the assumption of a correctly specified model, and we must ask whether classical least squares is the appropriate estimation method for the problem at hand.

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THE EFFECT OF ECONOMIC STATUS AND TRADITIONAL CULTURE UPON ECONOMIC BEHAVIOR: AN OPTIMISTIC COMMENT*

It has been an important general hypothesis in the development literature that traditional culture often implies low mobility and reluctance of people to change their economic behavior when offered a more profitable alternative. Kindleberger said, "A number of economists consider that a primary distinction between developed and underdeveloped economies lies in the efficacy of their price systems" [6, p. 99], and Schultz noted that "Indian economists have been especially fond of the refrain that prices do not matter" [8, p. 32].

This hypothesis has affected both policy decisions and our way of thinking about economic development. It directs attention away from manipulating economic variables in such a way as to produce short-run behavior favorable to development, and toward attempting to change basic elements of culture, a method which can work only slowly.

Schultz has recently presented a fresh and attractive point of view. He attacked the "insensitivity-to-economic-incentives" approach, not by directly asserting that traditional culture does not affect the willingness of underdeveloped peoples to alter their economic behavior, but rather by arguing that economic stimuli do indeed affect traditional peoples, and to an extent that we need not attend to cultural variables.

Despite all that has been written to show that farmers in poor commu-

nities are subject to all manner of cultural restraints that make them unresponsive to normal economic incentives in accepting a new agricultural factor, studies of the observed lags in the acceptance of particular new agricultural factors show that these lags are explained satisfactorily by profitability [and that poor farmers are sensitive to price]. . . . Since differences in profitability are a strong explanatory variable, it is not necessary to appeal to differences in personality, education and social environment [7, p. 164].

This view is more optimistic than the "insensitivity" approach, because it suggests that farmers in underdeveloped countries—who are a crucial bottleneck in the development of many countries and the persons most likely to be restrained by tradition—can be motivated to change their economic behavior in the short run.

I wish to offer a different point of view, which is even more optimistic than Schultz's. It has two parts. (1) Other things being equal, traditional culture may indeed mean a smaller area of discretion for people in underdeveloped countries, and a lower sensitivity to economic incentive. (2) Other things being equal, the poorer man, the more responsive he is to economic incentives, and the more willing he is to give up leisure and to break with traditional ways; that is, there is an inverse relationship between a person's economic status and his willingness to do what he does not "like" to do. The second part of the hypothesis is actually equivalent to a hypothesis of diminishing marginal utility of money.

Now follows some evidence that this point of view fits the facts.

* I am grateful to Professors Theodore W. Schultz and Marvin Frankel for careful reading and helpful comments, and to Professor Harold Guthrie for useful discussion.

1. Schultz cites (a) Krishna's finding that "the supply responses of farmers in the Punjab during the twenties and thirties [to changes in structural conditions] indicates that the lag in adjustment in producing cotton was about the same as it has been for cotton farmers in the United States" [7, p. 50], and (b) findings of Venkataramanan, Krishna, and Falcon of "impressively large" coefficients of adjustment to price changes, and especially Krishna's estimate, which "is not very different from that estimated in the United States" [8, pp. 32-33]. Schultz uses these findings to support his hypothesis that there is no *a priori* reason to believe that sensitivity and speed of adjustment are lower in underdeveloped countries than in developed countries. Of course, Schultz does not rule out differences in particular comparisons, but he sees no bias toward slower adjustment in traditional cultures.

High rates of adjustment in underdeveloped countries are in accord with my hypothesis, too, though they do not distinguish it from Schultz's point of view. I believe that the rate of adjustment in India is equal to that in the United States, because the higher *ceteris paribus* price sensitivity in India offsets the traditional culture which presses in the other direction. Schultz, however, tends to disregard cultural effects.

2. Kindleberger [6, p. 4] plotted hours of work in manufacturing per week against income per capita in 11 countries. The inverse relationship is startling in its almost perfect log-linearity. In poor countries, factory workers work longer hours than in rich countries. (Similarly, the work week has declined sharply in the United States as per capita income has risen

from the late nineteenth century.) On its face, this is evidence for the second part of my hypothesis. And if traditional culture *reduces* work time, Kindleberger's evidence becomes even stronger for the second part of the hypothesis.

3. In the United States, Glaser and Rice [2] find that there is an inverse relationship between employment (a reasonable proxy for income) and rates of property crime in the period 1930-1956. This finding supports my hypothesis. This time-series finding holds culture relatively constant.¹

4. The data on moonlighting suggests that, other things being equal, relative economic status is important in explaining people's choices between leisure and money [3, 4]:

a) Men with working wives moonlight less. A working wife is an important economic asset; the man whose wife works is richer than the man whose wife does not, and hence he works less.

b) Men with "disorderly work histories" moonlight more. A man with little job security has poorer prospects in present-value terms than the man whose job is secure, and hence he works more.

c) Moonlighting is positively related to number of children. It is probable that the more children a man has, the lower the value of his physical assets at any given moment. Hence, the more children a man has,

¹ Sociologists have long believed that the evidence on the income-crime relationship was in the other direction. The argument here focuses on less-developed countries even though this evidence is from the experience of developed countries. The hypothesis put forth here is intended to be universal, however, applying to all peoples everywhere.

the more leisure he can be expected to trade for money.

d) Even subjective poverty leads a man to work more. Wilensky [10] found that men who feel less well off than their parents are more likely to moonlight.

Taken together, the moonlighting data support the view that the poorer a man is, the more sensitive he is to economic opportunity.

5. The higher the economic status of college students in sororities at Berkeley, the lower their "achievement orientation," as measured by such variables as high grades and intention of working after graduation. Working for high grades in school can be interpreted as giving up leisure to increase later income [9].

6. As to the possible effects of culture on economic behavior, the social anthropologists and rural sociologists have documented in depth the great influence of noneconomic aspects of culture on economic behavior, [1, pp. 28-29; 5, Chap. 22]; the costly reverence for cows in India is a striking example. But culture constrains economic choices in the more-developed countries, too: the Amish, for example, farm with horses in central Illinois in 1968, and Israelis do not raise pigs even though it would be profitable for them to do so.

This short array of evidence certainly does not constitute an overwhelming showing for either element of the hypothesis, though in the absence of evidence to the contrary it does constitute a *prima facie* case. Nor have I asserted anything about the absolute strengths of the economic

and noneconomic cultural forces. Rather, I argue only that neither is unimportant relative to the other. Furthermore, this nonexperimental data cannot prove the basic hypothesis, because of the breaches of *ceteris paribus* on every hand; culture and economic status are clearly collinear in nature. Nevertheless, the data at least appear consistent with the hypothesis without requiring much auxiliary explanation.

This hypothesis is more optimistic than Schultz's because, while promising the same results from price incentives in the short run, it promises even greater results for the future if the underdeveloped countries remain poorer than the United States *and if modifications in traditional culture are also made*. In other words, this hypothesis offers the possibility of future development gains from cultural change which Schultz does not offer, while promising higher present results from economic incentives than the "insensitivity" hypothesis.

A metaphor characterizes the three points of view. The "insensitivity" view sees the underdeveloped-country man walking slowly to get an economic reward. Schultz and I both see him running to get the reward at a speed not necessarily slower than that of the developed-country man. But I see a weight dragging on the coat-tails of the underdeveloped-country man, and I assert that if this weight were removed he would run *faster* than the developed-country man to claim the reward because he is hungrier.

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Reviews are listed alphabetically by authors.

Reviews

Applebaum, William, and Ray A. Goldberg, *Brand Strategy in United States Food Marketing*, Boston, Harvard University, 1967, vii + 86 pp. (\$2.00)

The first section of this book develops a rather long-run perspective of the evolution of the "battle of the brands." The basis of this battle is the conflict between large food manufacturers with highly advertised brands and the lower-priced copies of these products carrying the brands of distributors such as food chains or group wholesalers. This section presents no new data, but does an excellent job of surveying available published material and developing what time-series and cross-sectional comparisons the data will support. The major data sources surveyed include a 1930 study by the Federal Trade Commission, a 1955 study by the Bureau of Economic and Business Research of the University of Illinois, a study of food marketing by the Federal Trade Commission, published in 1960, and the report of the National Commission on Food Marketing, published in 1966. By and large, the published data were taken in context. The comparisons and inferences seem to reflect the major propositions which can be supported by available data.

The conclusions of this section include the following: (1) The "battle of the brands" has not impaired the health of the food industry. (2) Private-label distribution has increased in absolute sales dollars and relative to national brands since 1930, although national brands may have made comebacks since 1960. (3) Distributors have strong business reasons for carrying private brands, including consumer loyalty and profit. (4) Distributors are likely to increase their private-brand activities in the future. (5) Distributor brands are not all profitable. (6) Consumers benefit from the "battle of the brands." (7) Manufacturers will continue to emphasize product differentiation.

The section entitled "Dynamic Brand Strategies" presents new data in substantially greater detail concerning gross and net profits and selling price of distributor brands and their competing manufacturer brands. Data presented ap-

parently represent the behavior of six retail food chains in three products: white bread, frozen orange concentrate, and margarine. This analysis places heavy emphasis on comparisons of net margins between private-label and manufacturers' branded products.

Conclusions drawn as a result of this analysis include the following: (1) Food retailers will continue to carry private labels in order to be competitive with private labels of competing food retailers, to provide a low-cost image, and to maintain price pressure on national brand manufacturers—despite considerations of profitability. (2) The “production pressure” stimulated by excess capacity and widespread technical know-how stimulates private-label programs. (3) The private-label mechanism enables the small food manufacturer to have access to a mass market with a minimum selling cost. (4) The rise of the U.S. standard of living, the unique wants of the many segments of our population, and the imagination and innovation of U. S. food processors suggest that manufacturers' brands will continue to be the dominant force in the grocery products industry. (5) Each firm in the U. S. processing system has the choice of satisfying a consumer's product or service need or using price as a main competitive weapon. If a firm cannot succeed in either of these broad alternative strategies, it will no longer be a part of the food industry.

These conclusions seem in general to reflect accurately the strategies and realities of private-label distribution. I would like to take exception, however, to the implication that direct product profit is not an important motivation for firms considering or engaging in private-label programs. Data presented seem a little too fragile to support a strong case either way, partly because a specific problem seems to be present in the data for white bread. The suggestion is made [p. 79] that the bread operations “show excellent manufacturing profits” while the data on net margins to the retailer suggest lower net profits than manufacturers' branded products. Where private-label distribution and vertical integration into physical processing functions are part of the same operation, it is only an arbitrary choice of transfer price that would make one profitable and the other unprofitable.

I also have great difficulty working up enthusiasm for retail net profit margins as an analytical device. My experience has indicated that net margins on individual items within the operations of the retail food stores are extremely difficult to develop. Allocation of retailing costs among the thousands of items requiring different amounts of processing and moving at substantially different rates is a formidable task. Furthermore, allocations of cost between private-label and manufacturer-brand products is complicated by the different responsibility the retailer takes in the case of each class of products.

Perhaps the most important aspect of the private-label phenomenon is that it represents a “price competitive” influence—created by action and initiative of the oligopoly core of food distributors. This is a strange animal which roams the plains freely, but cannot be found in the industrial organization zoo. Many implications flow from it, including a possible explanation why performance in the food distribution industry is better than the structural features might lead one to expect. Although some remarks in this work hint at this point, it is certainly not developed.

The primary contribution of this small paperback grows from the application of careful and scholarly work to a very timely and important subject. Its shortcomings result largely from the necessity of drawing conclusions from perilously thin data and a failure to identify the public welfare implications of structures and strategies discussed.

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Banner, Paul H., ed., *The Issue of Public Costs in Competitive Transportation Rate Making*, Washington, Southern Railway System, vi + 90 pp. (\$3.50)

Davidson, Jack R., and Howard W. Ottoson, eds., *Transportation Problems and Policies of the Trans-Missouri West*, Lincoln, University of Nebraska Press, 1968, xii + 377 pp. (\$7.95)

The past decade has witnessed significant change in agricultural transportation. Structural relationships in railroad rate systems that had persisted long enough to have attained a measure of traditional status have been substantially altered. New levels of public investment in highways and inland waterways, along with technological improvements in various modes of transport, have intensified intermodal competition and, in turn, intensified public policy issues related to regulation of competition between modes.

In many respects, both the consequences for agricultural shippers of new dimensions in intermodal competition in transportation and the unresolved regulatory policy issues dealing with intermodal competition were brought into sharp focus in the much publicized Southern Grain Rates case in 1962-63 (Grain in Multiple Car Shipments—River Crossings to the South, I & S Docket No. 7656).

Each of the two books included in this review relates to developments in the economics of transport or to public policy issues in transportation which were forced into more conscious general recognition in the above case. However, beyond dealing with problems in transportation whose current intensity of interest have a somewhat common origin, the two books have little in common.

Transportation Problems and Policies in the Trans-Missouri West contains 15 essays on agricultural transportation. In some cases, particular attention is given to problems of the 17 western states, but more generally, discussion applies to agricultural transportation problems throughout the United States.

The contributors combine training and professional experience in the economics of agriculture and in the economics of transportation. Various combinations of training in those specialized branches of economics are apparent in the essays. Problems and policy issues are approached primarily from the vantage point of the transportation economist in some of the essays and primarily from that of the agricultural economist in others.

Differences in points of view on particular issues occur throughout. For ex-

ample, contributors support different views regarding the status and prospects for vigorous competition among transportation agencies, the degree to which mergers and consolidations should be encouraged or even permitted, and the nature and extent of regulation desirable for various modes of transport. Transportation economists and agricultural economists are not polarized on controversial issues. Greater differences in viewpoint occur among contributors whose training is primarily transportation economics. Divergent views are strongly presented and provide strength and vigor, not weakness, in the series of essays.

Despite the unifying theme of agricultural transportation, this is not a highly cohesive set of essays. The range of transportation problems treated is very broad. There is little uniformity between topics in breadth of treatment or in temporal focus. Various essays tend to be more self-contained than interrelated. That perhaps is to be expected since the area of economic interrelationships between agriculture and the transportation system that serves it has not received extensive attention from either specialty in the past. No unifying body of references was available for guidance in selecting and developing of topics. Their individuality does not detract from the thoroughness and depth of insights contained in many of the essays, however.

In the final essay, Davidson and Ottoson have related topics discussed in earlier essays to potential for productive research on transportation problems. Theirs is well done. In an introductory statement the editors also have indicated a general awareness in the western states of a need for more insight into agricultural transportation problems. A realization of even a portion of the research suggested in the final essay would go far toward developing more thorough insights.

This is a significant book because it is an important step in exploring the interrelationships between the economics of agriculture and the economics of the transport system. It will provide a significant reference for many, particularly those concerned with public policy issues in agriculture and in transportation.

The Issue of Public Costs in Competitive Transportation Rate Making discusses conceptual and practical problems in determining and allocating public costs to barge transportation.

The Transportation Act of 1940 in a statement of national transportation policy declared the preservation of the inherent advantages of various modes as an objective of regulatory policy. The Interstate Commerce Commission in cases concerning intermodal competition has attempted to protect the inherent cost advantage of the low-cost carrier. In the Southern Grain Rates case (I & S Docket 7656) Southern Railway interests contended that relevant barge lines would not have an inherent cost advantage if barge costs included costs of public investments in navigation improvements and expenses of waterway maintenance.

The Commission rejected the use of public costs in determining inherent advantage, in part on procedural grounds, but buttressed its decision by stating practical difficulties of determining the amount of such costs. In the procedural issue the Commission said, "It is inconceivable that the Congress intended this Commission to exercise any veto power over its programs of inland waterway

improvement. Such a veto power, however, necessarily would be exercised whenever this Commission considered 'public costs' in evaluating in intermodal competitive rate cases the inherent advantages asserted by barge lines" [pp. 36-87].

On practical problems of public cost determination, the Commission said, "Even if the policy of Congress were not so well settled, it would be impossible for the Commission, as a practical matter, to allocate public costs among the multipurpose objectives of river and harbor improvements, not to mention the impossibility of assigning a fair share of 'public costs' so allocated to the cost structure of a particular carrier or group of carriers. . . . Such allocations are necessarily arbitrary" [p. 37].

Southern Railway interests concluded, following the statement of the Commission's position, that the major problem in admitting public costs in evidence was the difficulty in adducing public costs rather than the procedural question. Representatives of the Southern Railway contended that such costs could be computed with reasonable accuracy and subsequently undertook a project to prove the feasibility of computing public costs. This book is a report on that project.

There are three principal participants in Southern's study: (1) Professors William J. Baumol and Edward J. Kane of Mathematica, Inc., and Princeton University, who were given the task of evaluating conceptual problems concerning costs to be included and procedures for treating costs of public investment; (2) Ernst and Ernst, a public accounting firm, which was employed to determine and process detailed costs from one waterway section, a 195-mile section of the Mississippi River from the mouth of the Ohio River to the mouth of the Missouri River; (3) R. L. Banks and Associates, who reviewed all publications, annual reports, and pertinent previous studies and also were assigned the task of expressing waterway investments and certain maintenance expenses in annual costs.

Professors Baumol and Kane are straightforward and incisive in setting forth problems of cost allocation where outputs are produced jointly or in common. Also considered are problems of determining depreciation rates on capital investments and imputed interest rates on public investments, and ascertaining contributions of state and local units to construction and maintenance of waterway navigational aids.

For the most part the study is thorough and objective in evaluating information brought to bear on the problem. Inadequacies of available data and substantial areas of estimation and arbitrary allocation are recognized. The study does not solve the many knotty problems involved in assessment of costs and benefits of multipurpose public investments. It does detail and evaluate best available procedures. Recognizing limitations of costing techniques, Kane and Baumol defend the inclusion of best available estimates when waterway costs are relevant, stating that "though it is often forgotten, zero is no less arbitrary than any other" [p. 9].

Economists involved in evaluating costs and benefits of public investments of any type will find that time spent acquainting themselves with this study is

worthwhile. It is not a partisan presentation of a point of view but an objective approach to a very difficult analytical problem.

ORLO SORENSON
Kansas State University

Galbraith, John Kenneth, *The New Industrial State*, Boston, Houghton Mifflin Company, 1967, xi + 412 pp. (\$6.95)

Any book written by John Kenneth Galbraith is an unusual event. This is true not because his writings are rare for he is a prolific writer but rather because his are not ordinary books. They may not always represent substantial additions to knowledge, but they always represent a new way of looking at our society. They may not always be tightly organized, but they do present the observations of an experienced and discerning eye. It is also an unusual event because of the audience which is automatically commanded by Mr. Galbraith. His writings must be taken seriously because of the number of eyes that view his every word.

In view of the above it becomes crucial that a reviewer adopt identifiable criteria for an evaluation. He need not make such criteria explicit to others, but he must have such criteria or he will be at a complete loss in commenting on such a book. Should it be judged as serious work in new economic theory? If so, existence or paucity of researchable hypotheses would be a criterion for judgment. Should it be judged as a descriptive commentary on the present-day economy? If so, factual accuracy becomes important. Should it be judged in terms of political impact? If yes, the implication in terms of the distribution of political power becomes relevant. Very different judgments would be rendered on the book under review depending upon the criteria adopted. It is the opinion of this reviewer that the verdict on this book as a contribution to economic thought will be different from the verdict on either *American Capitalism: The Concept of Countervailing Power* or *The Affluent Society*.

We examine the economic system which Galbraith believes underlies the operation of a limited number of large corporations which produce a large share of private sector output.

1. The requirements of modern industry result in elaborate planning. These requirements consist of sophisticated decision making, large capital needs, complex technology, and capital commitment over long periods.

2. "Planning" as used in this context refers to the process of bringing within the control of these firms the major uncertainties that afflict traditional firms in a competitive economy. These include final product demand, product and factor prices, the supply of labor and raw materials, and the impact of new technology.

3. The planning process is conducted by the "technostructure." This group consists of all those within an organization who "bring specialized knowledge, talent or experience to group decision making." The technostructure represents

the guiding intelligence of the industry and serves as a replacement for the traditional entrepreneur.

What are characteristics of the "modern" as contrasted to the "traditional" industrial firm? The following are examples:

1. The technostructure does not look askance at big government. It tends to be allied closely with it and was not enthusiastic about Mr. Goldwater, who talked as though he intended to reduce the size of the government.

2. The modern industrial firm does not take consumer wants as given. It creates the demand for the product it desires to create and sell. (Incidentally, there seems to be some circular reasoning by Galbraith on this point.) The advertising industry is considered by Galbraith to be very necessary to the proper functioning of the industrial state. Consumer sovereignty is denied.

3. Profit maximization is "out"; sales enhancement is "in." Galbraith holds that the objectives of the technostructure are better met by sales enhancement than by profit maximization, which might be good for stockholders, but stockholders don't count because they are literally without influence.

4. Galbraith reserves his most sarcastic comments for economists' traditional treatment of the role of price. He believes that price is now largely under control of the industrial organization and that its role as an incentive is very different from that given to price in most economic writing.¹ We will return to this point later in the review.

In the final pages of the book Galbraith evaluates the performance of the industrial system. He concludes that its main weakness is in the composition of its output. He believes that the "non-market" goods which add to livability tend to be in short supply. This comes directly from his "affluent society," but the implications do not end here, of course. The industrial state is viewed with respect to its influence on unions, the scientific estate, education, and the State. The book, therefore, is sweeping in its scope in addition to its pretensions of depth relative to economic theory.

Galbraith provides a new description of the society in which we live. His observations of the impact of the large industries on the various aspects of our society are not at this point common knowledge, although if his book sales are any indication they probably soon will be. There is much in this description that is valuable. His is a discerning eye, and his is a brilliant pen. Yet there is danger even in his description. One is not sure of the underlying conceptual framework. As a consequence, one cannot be sure of what is useful knowledge, even though the reading is certainly most interesting. To the extent that the underlying conceptual framework and belief of "what is" is unacceptable or inaccurate, the resulting normative implications would obviously be unacceptable. For example, Galbraith's conclusions that our present antitrust policy makes little sense are acceptable only if one accepts his "imperatives" regarding needed scale to achieve the advantages of modern technology. Many other examples

¹ To illustrate his points about economists' treatment of price, Galbraith cites Dorfman's *The Price System* and Samuelson's *Economics*, 6th edition. The implication seems to be that if these Harvard men cannot do any better than they have regarding the role of price, there is surely no hope for the rest of the profession in their treatment of the same subject.

rational reallocation of resources would equate the land/labor ratios among the size-groups—that is, shift underemployed labor from small farms onto underutilized land on large farms.

Data, of course, is a difficulty in the studies. Capital data by farm size-group are given only in the Peru study (and in case studies in some of the other reports). Production data by size-group are not given in some of the studies. The Brazilian report, for example, does not give production but relies on the percentage of total farm area cultivated as an indicator to show that small farms use their land more intensively than large. Unfortunately, this approach is biased against the large farms, since, as farm size increases, the product mix shifts toward cattle grazing on natural pasture. Thus, as farm size increases, output per hectare does not fall as rapidly as percentage of area cultivated would imply.

If the major strength of the studies is to show that land and labor are misallocated within agriculture, the major weakness is that the studies do not take land quality into account. Do large farms have low output per hectare simply because their land quality is below average? Only the Colombia study presents comprehensive data on the value of land by farm size. It is interesting that if one examines output per land value (although the authors did not use their data in this way), the large farms do not appear to be performing so badly as in an analysis of output per land area; still, their performance is below average.

Of course, even land value is an unsatisfactory index of land quality and market proximity. The Brazilian study asserts that large tracts of land are in a thin market, different from the market for small plots. Prices are higher, for land of identical quality, in the small-plot market.

Another area in which the CIDA analysis could have been improved is the theoretical basis for misallocation of resources caused by land tenure. The studies do refer to noneconomic motivation of large owners (the holding of land for prestige). CIDA also refers to land speculation—the large owner may hold land as a portfolio asset in the face of inflation, without running the risks involved in using land as a productive factor. However, two other considerations also seem important. First, factor prices vary among size-groups because of market imperfections. The small farm has abundant labor with a preference for work on the family farm. The large owner must pay the “market” wage for labor, has relatively abundant land, and produces for profit, whereas the family farm could produce without regard to “profit” in order to meet its needs. (The works of Chayanov and Georgescu-Roegen are informative in this regard.)

Another factor-price distortion is in the capital market; as the CIDA studies point out, credit is more readily available to large farms than to small. Thus, even if a large farm is “modern” rather than traditional, it may be inefficient from the viewpoint of the economy as a whole. The large “modern” farm may produce with improper factor combinations—too much capital and too little labor, in view of the real costs of these factors to the economy. (This distortion is mentioned with regard to Chile and the Peruvian coast.)

A second theoretical consideration is the explanations which monopoly theory provides. A large farm may exert monopsony influence on the local labor market. To do so, the farm owner will buy land and hold much of it idle to prevent labor from having alternative sources of employment.

The CIDA studies contain valuable information on labor conditions, income distribution (especially the Chilean study), and general performance of agriculture. One general weakness with the studies would seem to be an excessive amount of space devoted to case studies, too few of which are given to permit generalization.

For historical and current information on land reform and colonization, the CIDA studies are rich sources. Finally, some of the studies contain cursory calculations which show the size of the land redistributions necessary to provide landless workers and small-farm families with sufficient land to be fully employed. These calculations show, on the one hand, the smallness of the efforts to date, and, on the other, the implicit gains in agricultural production that one might expect from land reform.

WILLIAM R. CLINE
Princeton University

Stakman, E. C., Richard Bradfield, and Paul C. Mangelsdorf, *Campaigns Against Hunger*, Cambridge, Harvard University Press, 1967, xvi + 328 pp. (\$7.50)

This volume is a straightforward, simply written account by a highly qualified American agricultural assistance team sponsored by the Rockefeller Foundation. As the book makes clear, the Foundation has played an important role since the early 1940's in triggering a food production revolution in Mexico and other countries. The three authors—E. C. Stakman, professor emeritus of plant pathology at the University of Minnesota; Richard Bradfield, professor emeritus of soil science at Cornell University; and Paul C. Mangelsdorf, professor of natural history and director of the Botanical Museum at Harvard University—were sent to Mexico by the Foundation in 1941 to appraise the needs and prospects for development of Mexican agriculture.

Written at the request of the Rockefeller Foundation, the book describes the initial efforts and findings of the 1941 survey; it traces the subsequent remarkable development in Mexican agriculture and the extension of the rural development effort to other nations. Finally, the authors set forth their conclusions as to the problems and pitfalls, as well as the procedures, attitudes, and skills, essential to agricultural development around the globe.

The central theme of the book is that the Rockefeller Foundation has for the past quarter of a century staffed, financed, and directed a highly successful international program of rural assistance and development. If the book has any significant weakness, it may stem from the impression it gives that the Rockefeller program was carried out in a nearly perfect manner and that little else of importance has happened on the rural development front since 1941 as a result of other efforts—public or private.

But in fairness to the authors, it should be noted that they make no claim to assessing anything other than the Rockefeller assistance program and the lessons which they and their fellow scientists have learned from that experience. They

tell their story and outline their conclusions with compelling enthusiasm and intense conviction. They leave little doubt that the campaign against human hunger is of the highest priority and that it will take the best in human commitment, motivation, intelligence, and applied science to win that campaign.

Anyone interested in the enormously challenging problems involved in the effort of the developed countries to assist the poorer people of the globe will find this book to be a well-informed, stimulating, and helpful source. The authors' conclusions as to the importance of basic education and self-help orientation in the developing countries, and the necessity of long-term, coordinated, soundly motivated assistance efforts by the richer countries, are well stated.

"Concentration and continuity of effort by competent, long-term personnel are essential," the authors contend, and this conviction is repeatedly emphasized throughout the book.

I would especially commend the final chapter to every person concerned with improving international assistance programs.

GEORGE MCGOVERN
United States Senate

Books for listing in this section should be sent to the Book Review Editor (see inside front cover for address)

Books Received

- Banner, Paul H., ed., *The Issue of Public Costs in Competitive Transportation Rate Making*, Washington, D.C., Marketing and Research Department, Southern Railway System, 1967, vi + 90 pp. \$3.50.
- Bass, Frank M., Charles W. King, and Edgar A. Pessemier, eds., *Applications of the Sciences in Marketing Management*, New York, John Wiley & Sons, Inc., 1968, xiv + 453 pp. Price unknown.
- Bennett, John W., *Hutterian Brethren: The Agricultural Economy and Social Organization of a Communal People*, Stanford, Stanford University Press, 1967, ix + 293 pp. \$8.00
- Cunha, T., A. Warnick, and M. Koger, eds., *Factors Affecting Calf Crop*, Gainesville, University of Florida Press, 1967, viii + 376 pp. \$12.50.
- Davidson, Jack R., and Howard W. Ottoson, eds., *Transportation Problems and Policies in the Trans-Missouri West*, Lincoln, University of Nebraska Press, 1968, xii + 377 pp. \$7.95.
- Farnsworth, Helen C., and Karen J. Friedmann, *French and EEC Grain Policies and Their Price Effects, 1920-1970*, Stanford Food Research Institute, Stanford University, 1967, 140 pp. \$2.50.
- Food and Agriculture Organization of the United Nations, *Agricultural Commodities-Projections for 1975 and 1985*, Vols. I & II, Rome, FAO, 1967, xxxviii + 647 pp. Price unknown.
- Food and Agriculture Organization of the United Nations, *FAO Commodity Review*, 1967, Rome, FAO, 1967, iii + 208 pp. Price unknown.
- Food and Agriculture Organization of the United Nations, *Production Yearbook 1966*, Vol. 20, New York, Columbia University Press, 1967, xvi + 763 pp. \$9.00.
- Fox, Karl A., *Intermediate Economic Statistics*, New York, John Wiley & Sons, Inc., 1968, x + 568 pp. \$13.50.
- Galbraith, John K., *The New Industrial State*, Boston, Houghton Mifflin Co., 1967, xiv + 427 pp. \$6.95.

- Good, Howard E., *Black Swamp Farm*, Columbus, Ohio State University, 1967, 304 pp. \$7.00.
- Goran, Morris, *The Story of Fritz Haber*, Norman, University of Oklahoma Press, 1967, xi + 212 pp. \$4.95.
- Goswami, P. C., *Dispur, A Study in Rural Change in Assam*, Jorhat, Assam, Agro-Economic Research Centre for North East India, 1967, viii + 165 pp. Rs. 8.
- Hannah, H. W., and Robert R. Caughey, *The Legal Base for Universities in Developing Countries*, Urbana, University of Illinois Press, 1967, xix + 455 pp. \$10.00.
- Hardin, Charles M., *Food and Fiber in the Nation's Politics*, Vol. III, Technical Papers, National Advisory Commission on Food and Fiber, Washington, D.C., Superintendent of Documents, August 1967, xi + 236 pp. Price unknown.
- Heady, Earl O., *A Primer on Food, Agriculture, and Public Policy*, New York, Random House, 1968, viii + 177 pp. \$4.95.
- Hinote, Hubert, *Benefit-Cost Analysis for Water Resource Projects: A Selected Annotated Bibliography*, Knoxville, Tennessee Valley Authority, 1967, iii + 105 pp. Price unknown.
- Hirschman, Albert O., *Development Projects Observed*, Washington, The Brookings Institution, 1967, xiv + 197 pp. \$2.25.
- Indian Society of Agricultural Economics, *Retrospect, 1939-1967*, Bombay, 1967, ii + 53 pp. Price unknown.
- Iowa State University Center for Agricultural and Economic Development, *Farmers and a Hungry World*, Ames, Iowa State University Press, 1967, 136 pp. Price unknown.
- Jain, S. C., *Agricultural Development of African Nations*, Vol. II, Bombay, Vora & Co., 1967, xi + 269 pp. \$6.00.
- Jones, E. L., *Agriculture and Economic Growth in England, 1650-1815*, New York, Barnes & Noble, Inc., 1967, ix + 195 pp. \$2.85 paper.
- Kerridge, Eric, *The Agricultural Revolution*, London, George Allen & Unwin, Ltd., 1967, 428 pp. 84 s.
- Millikan, Max F., and David Hapgood, *No Easy Harvest: The Dilemma of Agriculture in Underdeveloped Countries*, Boston, Little, Brown and Company, xiv + 178 pp. Price unknown.
- Miracle, Marvin P., *Agriculture in the Congo Basin*, Madison, The University of Wisconsin Press, 1967, xv + 355 pp. \$8.50.
- Myrdal, Gunnar, *Asian Drama, An Inquiry into the Poverty of Nations*, 3 vols., New York, Pantheon Books, 1968, lxii + 2284 pp. \$8.50 paper, \$25 cloth.
- Northrup, Herbert R., *Restrictive Labor Practices in the Supermarket Industry*, Philadelphia, University of Pennsylvania Press, 1967, xvi + 202 pp. \$7.50.
- Rudra, Ashok, *Relative Rates of Growth-Agriculture and Industry*, University of Bombay, 1967, distributed by P. C. Manaktala & Sons, Private Ltd., Bombay, India, 91 pp. Rs. 8/-.
- Schmitt, Gunther, ed., *Landwirtschaftliche Marktforschung in Deutschland*, Munchen, Bayerischer Landwirtschaftsverlag, 1967, 339 pp. DM 49.
- Smith, T. Lynn, *Colombia, Social*

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- Structure and the Process of Development*, Gainesville, University of Florida Press, 1968, xv + 389 pp. \$12.50.
- Steidl, Rose E., and Esther C. Bratton, *Work in the Home*, New York, John Wiley & Sons, Inc., 1968, xvi + 419 pp. \$9.95.
- Sturrock, Ford, *Farm Accounting and Management*, 5th ed., London, Sir Isaac Pitman & Sons, Ltd., 228 pp. 8s 6d net.
- Youngson, A. J., *Overhead Capital: A Study in Development Economics*, Chicago, Aldine Publishing Co., 1967, viii + 192 pp. \$6.75.

Announcements

CHANGE OF EDITORSHIP OF AJAE

Starting with the February 1969 issue, the new editorial staff of the *American Journal of Agricultural Economics* will be as follows:

Editor—Varden Fuller

Associate Editor—Harold O. Carter

Book Review Editor—Allen B. Paul

New submissions of manuscripts should now be sent to Varden Fuller, Department of Agricultural Economics, University of California, Berkeley, California 94720.

ANNUAL MEETING

AMERICAN AGRICULTURAL ECONOMICS ASSOCIATION AND WESTERN AGRICULTURAL ECONOMIC ASSOCIATION

AUGUST 18–21, MONTANA STATE UNIVERSITY
BOZEMAN, MONTANA

Preliminary Program

Sunday, August 18

- 9:00 a.m. Executive Committee Meeting
- 10:00 a.m. Registration
- 12:30 p.m. Lunch
- 4:00 p.m. Student Section: Reception, announcements, drawing
- 6:00 p.m. Student Section: Buffet supper
- 7:00 p.m. Reception: Members, families, students, and guests

Monday, August 19

- 8:00 a.m. Student Section: First round of preliminary debates
- 9:00 a.m. Welcome: LEON H. JOHNSON, President, Montana State University
GENERAL SESSION: Economic Policy
ROBERT MUNDELL, University of Chicago, *Currency Revaluation and Trade Policy*
KARL A. FOX, Iowa State University, *Agricultural Policy*
- 10:45 a.m. Recess
- 11:00 a.m. Chairman: HARRY TRELOGAN, Statistical Reporting Service
HAROLD F. BREIMYER, Presidential Address, *The AAEA and USDA in an Associationistic Age*
- 1:15 p.m. Student Section: Public speaking and debates
- 1:30 to 3:30 p.m. FORMAL SECTIONAL MEETINGS
Community Facilities and Services
Chairman: JOHN H. SOUTHERN, Economic Research Service
LEE DAY, Pennsylvania State University, *An Economic Framework for Analysis of Community Facilities and Services*
DAVID BALL, North Carolina State University, *Health Facilities and Services: The Manpower Dimension*

Discussants:

ALLAN SCHMID, Michigan State University

JOE B. STEVENS, Oregon State University

Economics of Stock Natural Resource Use

Chairman: JOHN FREY, Pennsylvania State University

S. V. CIRIACY-WANTRUP, University of California, Berkeley,
*Economic, Technological, and Policy Consideration of Stock
Resource Use*

WALTER MEAD, University of California, Santa Barbara, *Benefit-
Cost Analysis of Ocean Mineral Resource Development*

HERBERT GRUBB, Texas Technological College, *Ground Water
Utilization and Tax Policy*

Discussant:

DELWORTH GARDNER, Utah State University

A Critique of the PSAC Report on the World Food Problem

Chairman: WILLARD COCHRAN, University of Minnesota

MARTIN ABEL, Economic Research Service

LEROY BLAKESLEE, Washington State University

WESLEY G. SMITH, Tennessee Valley Authority

Firm Mergers and Market Structures

Chairman: W. R. HENRY, North Carolina State University

LEON GAROIAN AND C. CRAMER, Oregon State University, *Mer-
ger Component of Growth of Cooperatives*

PETER HELMBERGER, University of Wisconsin, *Impacts of Mer-
gers on General Welfare*

Discussants:

CALVIN BERRY, University of Arkansas

FILMORE E. BENDER, University of Maryland

Sources and Determinants of Incomes of Farm Families

Chairman: LUTHER TWEETEN, Oklahoma State University

JOSEPH COFFEY, The University of California, Berkeley, *Per-
sonal Distribution of Farmer Income by Sources*

J. P. MADDEN, Pennsylvania State University, *Shortcomings of
the Aggregate Demand Approach to Poverty Elimination*

Discussants:

PAUL BARELEY, Washington State University

RICHARD CROWDER, Wilson & Co.

Contributed Papers

3:45 p.m. **Discussion Meetings**

U.S. Census—Conrad Taeuber, Chairman

Farm Labor Task Force Report—Varden Fuller, Chairman

Computerized Farm Records—Thomas G. Brown, Chairman

Farm Bargaining Power—George W. Ladd, Chairman

5:00 p.m. Western Agricultural Economic Association Council

6:00 p.m. Student Section: Banquet

6:00 p.m. Industry Dinner, Speaker: RUSSELL O. AINES, International Min-
erals Corporation, *Economic Development Through Agribusi-
ness Consortia*

8:00 p.m. **An Evening with a Fellow**

Invited Lecture: T. W. SCHULTZ, University of Chicago

9:00 p.m. Plans for 1970 Meeting of International Association of Agricultural Economists

Tuesday, August 20

7:00 a.m. Student Section: Breakfast

8:30 a.m. Student Section: Debates

9:00 to

10:45 a.m. **GENERAL SESSION: Rural Poverty**

Chairman: JAMES BONNEN, Michigan State University

J. G. MADDOX, North Carolina State University, *An Historical Review of the Nation's Efforts to Cope with Rural Poverty*

W. W. MCPHERSON, University of Florida, *An Economic Critique of the National Advisory Commission Report on Rural Poverty*

Discussants:

W. B. BACK, Economic Research Service

KEITH BRYANT, University of Minnesota

E. WALTON JONES, North Carolina State University

10:30 a.m. Student Section: Semifinal debates

10:45 a.m. Recess

11:00 a.m. Annual Business Meeting AAEA

12:00 noon Ladies Luncheon

1:15 p.m. Student Section: Final debates

1:30 to

3:30 p.m. **FORMAL SECTIONAL MEETINGS**

The Changing Financial Structure of Commercial Agriculture

Chairman: JOHN BRAKE, Michigan State University

JOHN LEE, Chief, Agricultural Finance Branch, FPED, *Changes in the Financial Structure and Implications for Research*

C. B. BAKER, University of Illinois, *Financial Organization and Production Choices*

Discussants:

FRED TYNER, Louisiana State University

WILLIAM McD. HERR, Southern Illinois University

Redirecting Market Research

Chairman: JOSEPH PURCELL, University of Georgia

JAMES D. SHAFFER, Michigan State University, *New Orientations in Marketing Research*

LEONARD W. SCHRUBEN, Kansas State University, *The Systems Approach to Marketing Efficiency Research*

Discussants:

WILLARD F. WILLIAMS, Texas Technological College

LLOYD C. HALVERSON, Cooperative State Research Service

Economic Policy and Agricultural Development Abroad

Chairman: S. K. SEAVER, University of Connecticut

EDWARD SCHUH, Purdue University, *Effects of Exchange Policy on Agricultural Development*

LEE FLETCHER, Iowa State University, *Pricing Policy and Agricultural Development*

Discussants:

LYLE SCHERTZ, Deputy Administrator, International Agricultural Service

ROGER W. FOX, University of Arizona

Foreign Technical Assistance

Chairman: LOWELL S. HARDIN, The Ford Foundation

W. N. THOMPSON AND HAROLD GUTHER, University of Illinois, *The Impact of Overseas Technical Assistance on the U. S. University*

RALPH A. LOOMIS, Economic Research Service, Washington State University, *Why Overseas Technical Assistance Is Ineffective*

Discussants:

R. V. BILLINGSLEY, Texas A&M University

MELVIN G. BLASE, University of Missouri

Changing Criteria for Investment in Research and Education

Chairman: B. F. STANTON, Cornell University

D. KALDOR AND AENOLD PAULSEN, Iowa State University, *Investment in Research*

C. B. RATCHFORD, University of Missouri, *Investment in Education*

Discussants:

GEORGE BRINEGAR, University of Illinois

PETER DORNER, University of Wisconsin

3:00 p.m. Student Section: Business meeting

3:45 p.m. Contributed Papers

5:45 p.m. Banquet

8:00 p.m. Awards Program

Wednesday, August 21

7:30 a.m. Student Section: Breakfast and Executive Committee Meeting

8:00 a.m. Western Agricultural Economic Association, Business Meeting

9:00 a.m. FORMAL SECTIONAL MEETINGS

Macro Models of U. S. Agriculture

Chairman: H. O. CARTER, University of California, Davis

JERRY A. SHARPLES AND W. NEILL SCHALLER, Economic Research Service, *A Linear Programming Model for Predicting Aggregate Adjustments to Policy Alternatives*

EARL O. HEADY AND HARRY HALL, Iowa State University, *Linear and Nonlinear Spatial Models in Agricultural Competition, Land Use, and Production Potential*

Discussants:

GORDON A. KING, University of California, Davis

D. LEE BAWDEN, University of Wisconsin

Water Resource Economics

Chairman: WILLIAM LORD, University of Wisconsin

P. ZUSMAN, University of California, Berkeley, *Optimal Programs for Water Development in a Framework of Growth and Trade Models*

HARRY STEELE, Water Resources Council, *The National Water Resource Assessment and Comprehensive River Basin Planning*

EMERY CASTLE, Oregon State University, *Economics in Regional Water Research and Policy*

Quantitative Economics

Chairman: G. M. KUZNETS, University of California, Berkeley

GEORGE J. JUDGE, University of Illinois, *The Quest for Quantitative Economic Knowledge*

A. DEJANVRY AND J. BIERI, University of California, Berkeley, *The Problem of Degrees of Freedom*

Discussants:

JAMES B. HASSLER, University of Nebraska

ALBERT N. HALTER, Oregon State University

The Theory and Strategy of Community Development

Chairman: JOHN O. DUNBAR, Purdue University

ROLAND WARREN, Brandeis University, *The Theory of Community Development*

CARROLL BOTTUM, Purdue University, *Community Development Operation*

Discussants:

W. D. TOUSSAINT, North Carolina State University

L. T. WALLACE, University of California, Berkeley

Economics in Public Land Policy

Chairman: RUSSELL DUANE LLOYD, Forest Service

M. M. KELSO, University of Arizona, *Issues in the Application of Program Planning Budgeting Systems to Public Land Policies*

DON SEASTONE, Public Land Law Review Commission, *Tax Policy and Public Lands*

Discussants:

ARNOLD BOLLE, University of Montana

HOWARD HJORT, Program Evaluation Staff

DUES

Dues for 1968 are payable. The dues rate is as follows:

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sociation or AAEE, to C. D. Kearn, Secretary-Treasurer, AAEE, Department of Agricultural Economics, Cornell University, Ithaca, New York 14850.

BACK ISSUES OF JOURNAL OF FARM ECONOMICS NEEDED

The secretary-treasurer of the AAEE is authorized to pay \$1.00 each for any of the issues of the *JFE* listed below. Copies of the February 1965 issue particularly are needed.

<i>Year</i>	<i>Volume</i>	<i>Issues</i>	<i>Year</i>	<i>Volume</i>	<i>Issues</i>
1919	1	1, 2, 3	1945	27	2, 3, 4
1920	2	1, 2, 3, 4	1946	28	3
1921	3	1, 2, 3, 4	1947	29	1
1922	4	1, 2, 3, 4	1955	37	2, 5
1923	5	1, 2	1956	38	1, 2
1924	6	1, 2, 3, I	1957	39	1, 3-2
1925	7	1, 2, 4, I	1958	40	2, 3
1926	8	2, 3, 4, I	1961	43	4-1
1935	17	1	1962	44	3
1943	25	3	1965	47	1

JOURNALS should be mailed to C. Del Mar Kearn, Department of Agricultural Economics, 453 Warren Hall, Cornell University, Ithaca, New York 14850.

News Notes

PERSONAL

Medford Alexander resigned in September from the Department of Agricultural Economics and Farm Management, University of the West Indies, St. Augustine, Trinidad, to take up a postdoctoral fellowship at Ohio State University with the Poultry Science Department.

E. R. Alves, who completed his M.S. degree at Purdue University, is continuing for the Ph.D. at Purdue University.

Dale Anderson recently completed two years of military service and is now assistant professor of agricultural economics at the University of Nebraska.

M. S. Anderson, who completed his M.S. degree at Purdue University, is continuing for his Ph.D. work at Cornell University.

Chris Andrew, Ph.D. candidate at Michigan State University, is now instructor with the Nebraska MASUA mission in Bogota, Colombia.

Richard A. Andrews, associate professor, Department of Resource Economics, University of New Hampshire, is a visiting scholar in economics at MIT for the fiscal year 1967-68.

David Armstrong, associate professor at Southern Illinois University, is spending 1968 on sabbatic leave at Michigan State University.

Daniel Badger, professor at Oklahoma State University, is now an agricultural economist with the Nebraska MASUA program in Bogota, Colombia.

John Baird has resigned his position with the Economic Development Division, ERS, USDA, to accept employment with the National Science Foundation

F. Raeford Baker, instructor in agricultural economics and agribusiness at Louisiana State University, has resigned this position and accepted a position with the Organization for Economic Cooperation and Development in Paris, France.

Ward Bauder, Economic Development Division, ERS, USDA, is transferring from Ames, Iowa, to Ithaca, New York. He will undertake research with primary emphasis on manpower adjustment.

James Berry, research specialist in agricultural economics, University of Kentucky, has joined the Kentucky Contract Team for two years at Khon Kaen, Thailand.

James T. Bonnen, Michigan State University, has been selected by Carnegie Corporation and a task force of university presidents from the National Association of State Universities and Land-Grant Colleges to conduct a two-year study of the role of the university in public affairs. The study will be located at Michigan State University.

James R. Bowring, professor, Department of Resource Economics, University of New Hampshire, has been appointed chairman of that department.

Max Bowser, Ph.D. candidate at Oklahoma State University, is now instructor with the Nebraska MASUA mission in Bogota, Colombia.

David H. Boyne has assumed the chairmanship of the Department of Agricultural Economics and Rural Sociology at Ohio State University. The effective date of his appointment was November 1, 1967. He was formerly a member of the faculty in the Department of Agricultural Economics at Michigan State University.

C. A. Bratton, professor of farm management at Cornell University, is teaching an advanced farm management seminar while on leave at the University of Hawaii.

George Brinkman, Ph.D. candidate at Michigan State University, is now in Nigeria conducting research in the area of investments and education under the Midwestern University Consortium and the Consortium for the Study of Nigerian Rural Development.

W. Keith Burkett has transferred from the Economic Development Division, ERS, USDA, to the Bureau of Indian Affairs, Department of the Interior.

Oscar R. Burt, presently at the University of Missouri, has accepted a position as professor of agricultural economics at Montana State University beginning July 1968.

K. W. Burton has returned from an 18-month assignment abroad with the Purdue Fellows in Latin American Program at the Instituto Na-

cional de Tecnología Agropecuaria, Buenos Aires, Argentina.

E. L. Butz, dean of agriculture, Purdue University, has taken leave from the university and announced his candidacy for the Republican nomination for governor of Indiana.

Keith O. Campbell of the University of Sydney, Australia, is spending the spring term at Cornell University as a visiting professor in agricultural economics teaching and research.

Chaurcey T. K. Ching has resigned from the Farm Production Economics Division, ERS, USDA, Davis, California, to accept a position as assistant professor in the Department of Resource Economics of the University of New Hampshire.

Martin K. Christiansen of the University of Minnesota Department of Agricultural Economics and Agricultural Research Service has accepted a year's assignment with the Economic Research Service, U.S. Department of Agriculture, Washington, D.C.

Kwoh T. Chu, who recently completed his Ph.D. at the University of Maryland, is now teaching at Harvard University.

Elmo F. Clark retired on December 30, 1967, from his position as chief of the Transportation Services Branch, Transportation and Warehouse Division, C&MS.

Thomas Clevenger has joined the faculty of New Mexico State University after completing his Ph.D. at Michigan State University. He will conduct research and teach in the area of marketing.

Howard A. Clonts, who is completing his Ph.D. in agricultural economics at Virginia Polytechnic Institute,

has accepted a position as assistant professor, Department of Agricultural Economics and Rural Sociology, Auburn University, Auburn, Alabama.

Richard H. Clough has met Cornell University Ph.D. requirements and has joined the Ministry of Economic Planning and Development in Nairobi, Kenya.

Robert Coltrane, Economic Development Division, ERS, USDA, transferred from Morgantown, West Virginia, to Washington, D.C. He has been appointed leader of the Regional Programs Group, Area Analysis Branch.

Frank Conklin will join the faculty of the Department of Agricultural Economics at Oregon State University on July 1. He will do teaching and research in farm management and production economics. His initial assignment will deal with the economics of irrigated agriculture in the Pacific Northwest.

Gail Cramer, who recently completed work for his Ph.D. at Oregon State University, has joined the Department of Agricultural Economics at Montana State University. He will do teaching and research in the area of marketing.

David W. Culver joined the Economic and Statistical Analysis Division, ERS, USDA, on January 2, 1968. He is acting head of the Long Run Projections Section of the Outlook and Projections Branch. His previous position was assistant professor of economics at the University of Georgia.

R. W. Dickey has just returned from an 18-month assignment abroad with the Purdue Fellows in Latin American Program at the Estudio Ing. Barrutia, Buenos Aires, Argentina.

Jerry B. Eckert, Ph.D. candidate at Michigan State University, is now in Pakistan on a two-year assignment as an associate with the Ford Foundation.

Robert J. Eggert has been named director of the agribusiness program at Michigan State University. He holds appointments in both the College of Business and the College of Agriculture and Natural Resources. Prior to January 1, he had served 17 years with Ford Motor Company and had worked for the American Meat Institute.

Mordecai Ezekiel is spending the spring semester as professor of agricultural economics at the University of Arizona, Tucson.

Gerald Feaster, Ph.D. candidate at the University of Kentucky, is now instructor with the Nebraska MASUA mission in Bogota, Colombia.

Thomas Foster has been appointed instructor in the Department of Agricultural Economics and Agribusiness at Louisiana State University.

Joe E. Fuqua, assistant professor, University of Kentucky, has accepted a position as area extension specialist in farm management. He will be stationed in west Kentucky.

W. M. Gauthier, who completed his M.S. at Purdue University, is now in the Armed Services.

Georgui T. Georgiev, on leave from the Institute of the Economics and Organization of Agriculture, Bulgarian Academy of Agricultural Sciences, Sofia, Bulgaria, is visiting research specialist in the Department of Agricultural Economics, University of Minnesota. He is working with Philip M. Raup in the area of farm organization and structural planning in agriculture.

Gerald Giesler has been appointed instructor in the Department of Agricultural Economics and Agribusiness at Louisiana State University.

J. A. Ginzel has returned from an 18-month assignment abroad with the Purdue Fellows in Latin American Program at the Fundacao Getulio Vargas, Rio de Janeiro, Brazil.

George H. Goldsborough, director, Matching Fund Program, C&MS, received a USDA Certificate of Merit and a quality increase in salary for "sustained excellence in directing the Matching Fund Program leading to expanded marketing services by State Departments of Agriculture and increasing cooperation between State and Federal marketing agencies."

Russell Gum has joined the staff at the University of Arizona as cooperative agent, ERS-Arizona, after receiving his doctorate at the University of California, Davis.

David E. Hahn joined the faculty in the Department of Agricultural Economics and Rural Sociology at Ohio State University in September of 1967. He will teach and do research in the area of agricultural marketing.

Robin G. Henning, who received the Ph.D. degree from Cornell University in 1967, is now with the Specialty Crops Branch, Fruit and Vegetable Division, USDA.

Henry G. Herrell retired on December 4, 1967, from his position as deputy administrator for management in the Consumer and Marketing Service.

Peter Hildebrand has left the AID mission in Bogota, Colombia, and is now with the Nebraska MASUA mission in Bogota.

F. J. Hitzhusen, who completed his

M.S. at Purdue University, is continuing at Purdue toward his Ph.D. degree.

Oliver W. Holmes, ERS, USDA, has been reassigned from Columbia, Missouri, to Washington, D.C. His new research assignment is in the Poverty Analysis Section of the Human Resources Branch, Economic Development Division.

Richard Hopkins, a graduate student, University of New Hampshire, has gone to work for the United Fruit Company, Inc., Boston, Massachusetts.

Andrew C. Hudson, Ph.D., Louisiana State University, May 1967, has accepted a position as agricultural economist with the Agricultural Economics and Natural Resources Division of Economic Research, USDA, at Little Rock, Arkansas.

O. B. Jesness, emeritus professor, University of Minnesota, was awarded a Fiftieth Anniversary Commemorative Medal by the Federal Land Bank for outstanding contributions to agriculture.

Richard Jesse has been appointed instructor in the Department of Agricultural Economics and Agribusiness at Louisiana State University.

Helen W. Johnson, Economic Development Division, ERS, USDA, was recently awarded a Certificate of Merit for sustained above-average performance in developing materials for special purposes and for conducting research relating to the less advantaged segments of rural America.

R. F. Jones, Purdue University, has been appointed assistant project leader, Purdue Project, Rural University of Minas Gerais, Vicosa, Brazil.

Timothy Josling has joined the faculty

of the London School of Economics after completing his Ph.D. program at Michigan State University.

J. W. Judy, Jr., who completed his Ph.D. at Purdue University, will continue on the staff there. Dr. Judy has a D.V.M. and will be working in interdisciplinary work between the School of Veterinary Medicine and the Department of Agricultural Economics.

George C. Knapp has been appointed deputy administrator for management for the Consumer and Marketing Service.

Henry A. Knopf has received the Ph.D. degree from Cornell University and is now professor of economics at Niagara University, Niagara Falls, New York.

E. Fred Koller, professor, University of Minnesota, was awarded a Fiftieth Anniversary Commemorative Medal by the Federal Land Bank for outstanding contributions to agriculture.

Halvor J. Kolshus, research specialist in agricultural economics, University of Kentucky, has joined the Kentucky Contract Team for two years at Khon Kaen, Thailand.

Kenneth R. Krause has joined the staff of the Farm Production Economics Division, ERS, USDA, Washington, D.C. He was assistant professor of economics at South Dakota State University.

Larry N. Langemeier has been appointed extension economist for farm management studies at Kansas State University.

James H. Lauth has been appointed chief of the Transportation Services Branch, Transportation and Warehouse Division, C&MS. He previously served as assistant to the director of the division.

Tsoun-Chao Lee, Ph.D. University of Illinois, has been appointed assistant professor in the Department of Agricultural Economics at the University of Connecticut.

Rodney E. Leonard has been designated administrator of the Consumer and Marketing Service by Secretary of Agriculture Orville L. Freeman. He replaces S. R. Smith, who has retired from government service. Mr. Leonard is a former aide to the governor of Minnesota and since March 1966 has served as deputy assistant secretary for Marketing and Consumer Services.

W. Bernard Lester, formerly with USDA, Department of Agricultural Economics, Texas A&M University, has joined the staff of the Department of Agricultural Economics at the University of Florida as a research economist with the Florida Citrus Commission.

Charles Harvey Little has accepted a position as assistant professor of economics and experimental statistics at North Carolina State University.

James H. Lovering has received the Ph.D. degree from Cornell University and has joined the Economics Branch of the Canadian Department of Agriculture, Regina, Saskatchewan.

Oscar M. Lund, Jr., formerly instructor at Bethel College, St. Paul, has joined the faculty of the University of Minnesota as research fellow in the Department of Agricultural Economics and Agricultural Extension Service. His appointment is for two years and his responsibilities will involve research in the area of locational characteristics of nonmetropolitan industries in Minnesota.

Gale H. Lyon, who recently completed his Ph.D. at the University

of Maryland, is currently employed at the Federal Extension Service, USDA.

Loys L. Mather, University of Wisconsin, has joined the research and teaching staff at the University of Kentucky as assistant professor, effective February 1.

Elmer Menzie returned to his position as professor of agricultural economics at the University of Arizona after serving in Fortaleza, Brazil, for three and a half years with the AID-University of Arizona contract.

Clarence J. Miller, of the Stanford Research Institute, has accepted appointment as chief of party for a two-year SRI-AID contract in Ethiopia, where the team will study ways to modernize agriculture and agro-industry.

W. H. M. Morris, Purdue University, taking sabbatic leave at the Dutch Agricultural College, will be working in the Department of Farm Mechanization and Agricultural Economics and will be giving lectures and doing research on labor productivity.

Lester H. Myers, after completing his Ph.D. degree at Purdue University, has joined the staff of the Department of Agricultural Economics at the University of Florida with the Florida Citrus Commission.

David M. Nelson, who has completed his Ph.D. degree at Kansas State University, has joined the faculty of the University of Minnesota as research associate in the Department of Agricultural Economics and Agricultural Extension Service. His appointment is for two years and his responsibilities will be in the area of urban and recreation economics.

T. Everett Nichols joined the staff of the Federal Extension Service, U. S. Department of Agriculture,

Washington, D.C., on January 2. Dr. Nichols is serving as extension marketing economist, primarily with grain marketing and transportation programs. He will serve for one year under an exchange agreement with North Carolina State University.

Dupe Olatunbosun has joined the staff of NISER (Nigerian Institute for Social and Economic Research) at the University of Ibadan after completing his Ph.D. at Michigan State University.

Frank H. Osterhoudt, who recently completed requirements for the Ph.D. at the University of Wisconsin, has joined the staff of the Department of Agricultural Economics and Agricultural Business at New Mexico State University as an assistant professor. He will teach and conduct research in the field of water resource economics.

J. B. Penn, M.S., Louisiana State University, has accepted a position as an agricultural economist with the USDA at Louisiana State University.

Richard Kidd Perrin has joined the faculty of economics as an assistant professor at North Carolina State University.

Thomas T. Poleman has returned to the Cornell University Department of Agricultural Economics from an assignment as visiting professor at Makerere University College in Uganda under a Rockefeller Foundation grant.

Ray Prewett, who is completing a Master's degree at Purdue University, will fill the position of extension resource development economist at Texas A&M University about June 1.

David Schmidt received his M.S. degree from the University of Ken-

tucky and was commissioned as a second lieutenant in the U. S. Air Force.

Robert W. Schoeff of the Department of Grain Science and Industry, Kansas State University, has taken a six-month leave of absence to accept a contract assignment with the Farm Production Economics Division, ERS, USDA, Washington, D.C. He will head a project to develop a program for better statistics of annual production and consumption of formula feeds, where use is rapidly increasing. He expects to return to the university about July 1.

G. E. Schuh, Purdue University, has been appointed to the National Academy of Science—Conselho Nacional de Pesquisas do Brasil Joint Study Group on Agricultural Economics. The first meeting of this group was in Rio de Janeiro on January 21–31, 1968.

Kent D. Schuyler has accepted a position with the U. S. Bureau of Reclamation at the Snake River Development Office, Boise, Idaho.

S. M. Shah, joint director, resumed his duties with the Indian Planning Commission, New Delhi, in December 1967, on completion of the visiting arrangement of nine months at the Department of Economics, University of Chicago, where he worked on "Economic Development and Agriculture."

Leon Shashoua received his Cornell University Ph.D. degree and is now an economist with the National Agricultural Bank (Lehakela'ut), Tel Aviv, Israel.

Cecil N. Smith, Department of Agricultural Economics, University of Florida, has recently returned from a two-year assignment in Costa Rica as chief of party, USAID, Uni-

versity of Florida—Costa Rican Contract.

Eldon D. Smith, professor of agricultural economics, University of Kentucky, has joined the Kentucky Contract Team for two years at Khon Kaen, Thailand.

Harold D. Smith, professor, Department of Agricultural Economics, University of Maryland, has been appointed associate director, Maryland Cooperative Extension Service, effective February 12, 1968.

Richard B. Smith has joined the Farm Production Economics Division, ERS, USDA, at Ames, Iowa.

S. R. (Si) Smith has retired from his position as administrator of the Consumer and Marketing Service. He entered the Department of Agriculture in 1934 as an agricultural economist. During World War II he served as deputy director for civilian programs in the War Food Administration. After the war he was named director of the Fruit and Vegetable Branch of the Production and Marketing Administration. He received USDA's Distinguished Service Award in 1956 and was named administrator of the Agricultural Marketing Service (now C&MS) in June 1961.

D. W. Thomas, Purdue University, has been appointed to the National Academy of Science—Conselho Nacional de Pesquisas do Brasil Joint Study Group on Agricultural Economics. The group held its first meeting in Rio de Janeiro on January 21–31, 1968.

Harry C. Trelogan, administrator, Statistical Reporting Service, USDA, Washington, D.C., was one of a group of distinguished honorees to receive the Fiftieth Anniversary Medal of the Twelve Land Banks on December 18, 1967. Honorable Robert B. Tootell, governor, Farm

Credit Administration, presented the medal on behalf of the Federal Land Bank presidents.

Arthur W. True retired from his position as staff assistant, Office of the Administrator, ERS, USDA, after over 39 years of government service.

E. Dean Vaughan, formerly assistant director, Division of Marketing and Utilization Sciences, Federal Extension Service, Washington, D.C., became director, Division of 4-H and Youth Development, FES, October 1, 1967.

Nobel T. Veal has transferred from the Statistical Reporting Service, USDA, to become head of the Data Processing Group in the Farm Production Economics Division, ERS, USDA, Washington, D.C.

Warren Vincent, Michigan State University, has returned to East Lansing after his assignment in Nigeria.

Norman J. Wall of the Farm Production Economics Division, ERS, USDA, Washington, D.C., has been awarded the Federal Land Bank System's Fiftieth Anniversary Medallion in recognition of his long and meritorious service to agricultural credit.

Thomas T. Weaver received his Cornell University Ph.D. degree and has joined the Faculty of Agriculture, University of Malaysia, Kuala Lumpur, Malaysia.

R. N. Weigle, Purdue University, has resigned to accept a position as associate professor, Department of Agricultural Economics, University of Wisconsin, to specialize in production economics and farm management.

Kelso Wessell joined the faculty of the Department of Agricultural Economics and Rural Sociology at Ohio State University in February of

1968. He will join the Ohio State Contract Team in Brazil for a period of two years.

Hoyt A. Wheeland has resigned from the Economics Division of the USDA-Forest Service and has accepted a position as industry economist with the Branch of Current Economic Analysis in the Bureau of Commercial Fisheries.

John Wildermuth joined the staff at the University of Arizona, Tucson, after receiving his Ph.D. at the University of California, Davis.

Roger H. Wilkowske, dairy marketing economist, transferred from the Kansas Agricultural Extension Service to the Federal Extension Service, USDA, Washington, effective January 1, 1968.

J. F. Willis, who completed his M.S. degree at Purdue University, has accepted a position as decision systems analyst, Weyerhaeuser Company, Tacoma, Washington.

L. W. Witt, Michigan State University, has been appointed to the National Academy of Science—Conselho Nacional de Pesquisas do Brasil Joint Study Group on Agricultural Economics. The group held its first meeting in Rio de Janeiro on January 21-31, 1968.

Dennis H. Wood, who recently completed his Ph.D. at the University of Maryland, has entered Harvard University Law School.

A. D. Wycliffe, who completed his Ph.D. at Purdue University, has returned to his position as head, Department of Agricultural Economics, Allahabad Agricultural Institute, Allahabad, India.

Larry E. Yost, who recently completed his Ph.D. at the University of Maryland, is currently employed by the West Virginia Cooperative Extension Service.

ORGANIZATIONAL

The University of Minnesota Agricultural Experiment Station has available a number of copies of Technical Bulletins 231 and 238, *Policies for Expanding the Demand for Farm Products in the United States*, Part I, *History and Potentials*, and Part

II, *Programs and Results*. These publications came out of an inter-regional policy project in 1959, and copies may be obtained free of charge by writing to the Minnesota station.

DOCTORAL DEGREES CONFERRED IN
AGRICULTURAL ECONOMICS, 1967

Fred H. Abel, B.S. Michigan State University, 1959; M.S. University of Delaware, 1961; Ph.D. Michigan State University, *A Procedure for Measuring the Separate Effects of Man-Controlled Inputs and Weather on Yields—Applied to Grain Sorghum Yields*.

Ramesh Chandra Agrawal, B.S. Agra University, 1953; M.S. Agra University, 1955; Ph.D. Iowa State University, *Applications of Operations Research Techniques in Agriculture*.

Paul Aldunate, B.S. Catholic University, Santiago, Chile, 1962; M.S. Purdue University, 1965; Ph.D. Purdue University, *Labor and Capital Sectoral Allocation in the Chilean Economy: A Linear Programming Macro-economic Model*.

Moshe Ben-David, B.S. Hebrew University, 1957; M.S. Hebrew University, 1961; Ph.D. Michigan State University, *Farm-Nonfarm Income Differentials for the United States*, 1960.

Leroy L. Blakeslee, B.S. Cornell University, 1957; Ph.D. Iowa State University, *An Analysis of Projected World Food Production and Demand in 1970, 1985 and 2000*.

Sergio Brandt, Ag. Engineering, Universidade Rural do Estado de Minas,

1956; M.S. Purdue University, 1963; Ph.D. Ohio State University, *Spatial Analysis of the World Coffee Market: The Brazilian Competitive Position*.

Thomas Glenn Brown, B.S. University of Missouri, 1949; M.S. University of Missouri, 1959; Ph.D. North Carolina State University, *Estimating the Production Potential of Selected Vegetable Crops for Processing in Southeast Missouri*.

Boyd M. Buxton, B.S. Brigham Young University, 1960; M.A. Washington State University, 1963; Ph.D. University of Minnesota, *Economies of Size in Minnesota Dairy Farming*.

Jo Chun Chai, B.S. Kyong Puk University, 1956; Ph.D. University of Minnesota, *An Economic Analysis of the Demand and Price Structure of Wheat for Food by Classes in the United States*.

Hsing Yiu Chen, B.S. National Taiwan University, 1954; M.S. Ohio State University, 1958; Ph.D. Ohio State University, *Structure and Productivity of Capital in the Agriculture of Taiwan and Their Policy Implications to Agricultural Finance*.

Chauncey T. K. Ching, B.S. University of California, 1962; M.S. University of California, 1965; Ph.D.

- University of California, *Range Cattle Supply Response in California, An Economic Study*.
- Parimal Choudhury**, B. Commerce, University of Calcutta, India, 1959; M.S. University of Hawaii, 1965; Ph.D. University of Hawaii, *An Econometric Appraisal of the Aggregate Sugar Supply Response for Selected Major Producing Countries*.
- Robert Lawrence Christensen**, B.S. Michigan State University, 1958; M.S. University of Delaware, 1960; Ph.D. North Carolina State University, *A Study of the Relation Between Income and Egg Consumption Using Consumer Panel Data*.
- Tjai Kwo Chu**, M.A. University of Maryland; M.E.E. Catholic University; Ph.D. University of Maryland, *The Economics of Rural Electrification*.
- David Woodruff Cobia**, B.S. Bingham Young University, 1960; M.S. Purdue University, 1963; Ph.D. Purdue University, *External Growth of Dominant Firms in the Grain Processing and Merchandising Industries*.
- Gerald L. Cole**, B.S. Michigan State University, 1957; M.S. University of Delaware, 1959; Ph.D. Michigan State University, *Toward the Measurement of Demand for Outdoor Recreation in the Philadelphia-Baltimore-Washington Metropolitan Region with Implication for Agricultural Resource Use*.
- George Joseph Conneman, Jr.**, B.S. (with Distinction) Cornell University, 1952; M.S. Cornell University, 1956; Ph.D. The Pennsylvania State University, *A Methodological Study of Representative Farm Groups and Alternative Methods of Analyzing and Projecting Changes in Milk Production*.
- Melvin L. Cotner**, B.S. Kansas State University, 1949; M.S. Kansas State University, 1955; Ph.D. Michigan State University, *The Potential Role of Agricultural Land Drainage in Economic Growth*.
- Thomas D. Crocker**, A.B. Bowdoin College, 1959; Ph.D. University of Missouri, *Some Economics of Air Pollution Control*.
- Ashok Eumar Dar**, B.A. St. Stephen's College, Delhi, India, 1955; M.A. Delhi School of Economics, 1958; Ph.D. Cornell University, *Domestic Terms of Trade and Economic Development in India*.
- Buddy Leroy Dillman**, B.S. University of Arkansas, 1959; M.S. University of Arkansas, 1962; Ph.D. North Carolina State University, *Local Government Social Overhead Expenditures and Economic Growth in the Appalachian Region*.
- John F. Douglas, Jr.**, A.B. Harvard University, 1948; Ph.D. Iowa State University, *Uses of Linear Programming Techniques in the Fertilizer Industry*.
- W. David Downey**, B.A. Purdue University, 1961; M.S. Purdue University, 1963; Ph.D. Purdue University, *Customer Services and Promotions in Supermarkets*.
- Mohammad Ragaa Abd-Elfattah El-Ami**, B.S. University of Cairo, 1955; M.S. University of Alexandria, 1960; Ph.D. University of California, *Location Models for the World Rice Industry*.
- Kamal El-Ganzoury**, B.S. Cairo University, 1957; M.S. Cairo University, 1962; Ph.D. Michigan State University, *Changes in United States Cotton Yields, 1939-1959—The Influences of Weather, Technology and Economic Factors*.
- Nolan Eugene Engel**, B.S. University of Nebraska, 1954; M.S. University

- of Connecticut, 1959; Ph.D. University of Connecticut, *A Spatial Equilibrium Stochastic Supply: A Study of the Fall Potato Industry*.
- Donald James Epp**, B.S. University of Nebraska, 1961; M.S. Michigan State University, 1964; Ph.D. Michigan State University, *The Impact of Agricultural Policies on Regional Grain and Livestock Prices in the European Economic Community*.
- Alva Lewis Erisman**, B.S. University of Illinois, 1956; M.S. University of Illinois, 1957; Ph.D. University of Maryland, *Potential Costs of and Benefits from Diverting River Flow for Irrigation in the North China Plain*.
- Sidney Horace Evans**, B.S. Virginia State College, 1943; M.S. Iowa State University, 1947; Ph.D. Ohio State University, *Analysis of Costs and Benefits from Commuting for Employment Among Core and Satellite Communities in the Appalachian Region of Ohio*.
- Chwei Lin Fan**, B. Agric. National Kwangsi University, China, 1947; M.S. Montana State College, 1961; Ph.D. University of Hawaii, *Determinations of Sugar Supply Functions in Taiwan*.
- Barry Charles Field**, B.S. Cornell University, 1956; M.S. Cornell University, 1959; Ph.D. University of California, *The Impact of Changing Economic Structure on the Strategy of Agricultural Policy: The Case of Cotton*.
- Charles Lynn Fife**, B.S. Brigham Young University, 1959; M.S. Oregon State College, 1961; Ph.D., Purdue University, *The Decision-Making Process in Large Independent Fluid Milk Firms in the Midwest*.
- Bruce J. Florea**, B.S. University of Missouri, 1948; M.S. University of Missouri, 1964; Ph.D. University of Missouri, *Scale Economies in Feeding Cattle Under Different Systems of Management*.
- James Richard Garrett**, B.S. New Mexico State University, 1958; M.S. New Mexico State University, 1961; Ph.D. Washington State University, *Economies of Scale of Livestock Auctions in the Pacific Northwest*.
- Clendon Kerry Gee**, B.S. Utah State University, 1961; M.S. Utah State University, 1962; Ph.D. Oregon State University, *An Analysis of Factors Which Contribute to Differences Between Actual and Programmed Optimum Organization on Individual Farm Units*.
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The Impact of Managerial Ability and Capital Structure on Growth of the Farm Firm*

GEORGE F. PATRICK AND LUDWIG M. EISGRUBER

A simulation model of farm firm behavior in a dynamic environment with elements of uncertainty was developed. The decision maker's formulation of expectations regarding future prices and yields, his selection of alternative farm plans, evaluation of the expected outcomes of the plans with respect to four goals, and implementation of the plan offering the highest level of overall satisfaction are explicitly considered. The expectations, goals, and resource position of the firm are adjusted to reflect the outcome of the particular plan implemented, and the process is repeated for the next year. A case was simulated for a period of 20 years under three different levels of managerial ability and 27 different capital market structures. It is concluded that managerial ability and long-term loan limits are the major factors, among those considered, influencing farm firm growth.

TRADITIONAL economic theory fails to reflect the nature of important intrafirm relationships and possible differences which may exist among firms. More specifically, in the case of the farm firm, it is important to recognize that it is an individual proprietorship and a composite of the farm family and the physical and financial resources composing the business unit [2, 6, 9]. Whether competitive or complementary, the farm business and family are not independent, because of considerations of time, limited capital, and uncertainty.

This article reports the development of a model of farm firm behavior in a dynamic environment with elements of uncertainty. A part of this model is concerned with the decision-making process of the farm firm. Particular emphasis is laid on the effects of changes in the managerial ability of the farm operator and in the capital structure.

A Behavioral Theory of the Farm Firm

"Behavior" is a term commonly used by biological scientists in describing the reaction of an organism to a stimulus or its conduct in relation to its environment. "Behavioral theory," then, connotes a theory of the manner of response. Adapting the term to economics, we may say that a behavioral theory of the firm would show how changes in the internal characteristics of the firm, resulting from changes in the relative importance of various goals, would cause a firm to respond differently to the same conditions at different times [5].

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Elements of a behavioral theory

Human behavior is goal-oriented. An individual's *goal* is an objective or condition, not yet reached, that provides direction to his motivation and hence to his behavior. Values are a normative concept, of higher order than goals and more enduring. A value is "a conception, explicit or implicit, distinctive of an individual—of the desirable which influences the selection from available modes, means, and ends of action" [12, p. 395].

An individual does not strive solely for the satisfaction of a single goal; rather, he is positively oriented toward the attainment of a number of goals simultaneously. These goals may be competitive, complementary, or independent. The farm firm is influenced by goals of the operator himself, goals of other members of his family, goals common to all families, and, possibly, goals unique to farm families. Often there is conflict, either in the goals themselves or in the relative importance attached to them by the farmer and other members of the family [9, pp. 431–432].

As a reflection of the present situation and the desires of the farm family for the future, goals can change in relative importance over the course of time. These goals form a multivariate objective function against which the expected outcomes of various alternatives are evaluated. The multivariate form of the objective function forces the decision maker to strive for an operational organization such that all goals are attained at a satisfactory level. Selecting a plan that attains all goals at a minimum level of satisfaction constrains the possibility of maximization of a single goal at the expense of all others.

Imperfect knowledge with regard to the future forces the farmer to rely on his expectations in planning. The expectations change as the farmer has new experiences and may, in part, be a function of the managerial ability of the decision maker. Since knowledge concerning the future is not perfect, the decision maker must allow for uncertainty—the possibility of incorrect expectations in deciding to commit resources to a particular combination of enterprises or types of inputs.

Limitations of time and computational ability cause the farmer to consider only a subset of the possible alternatives available to him. Among the factors determining which alternatives are considered, some are personal in nature, some are institutional, and some are related to business.

As a theory of the manner of response, a behavioral theory of the firm focuses primarily on the decision maker and his environment. At various points, new information may cause a farmer to redefine his problem, seek more information, set up other alternatives, or accept a previously evaluated alternative.

The foregoing elements and principles of a behavioral theory of the firm need to be related to each other. Figure 1 is an attempt to show the relationships and continuous interactions of the major elements of a behavioral model of the farm firm.

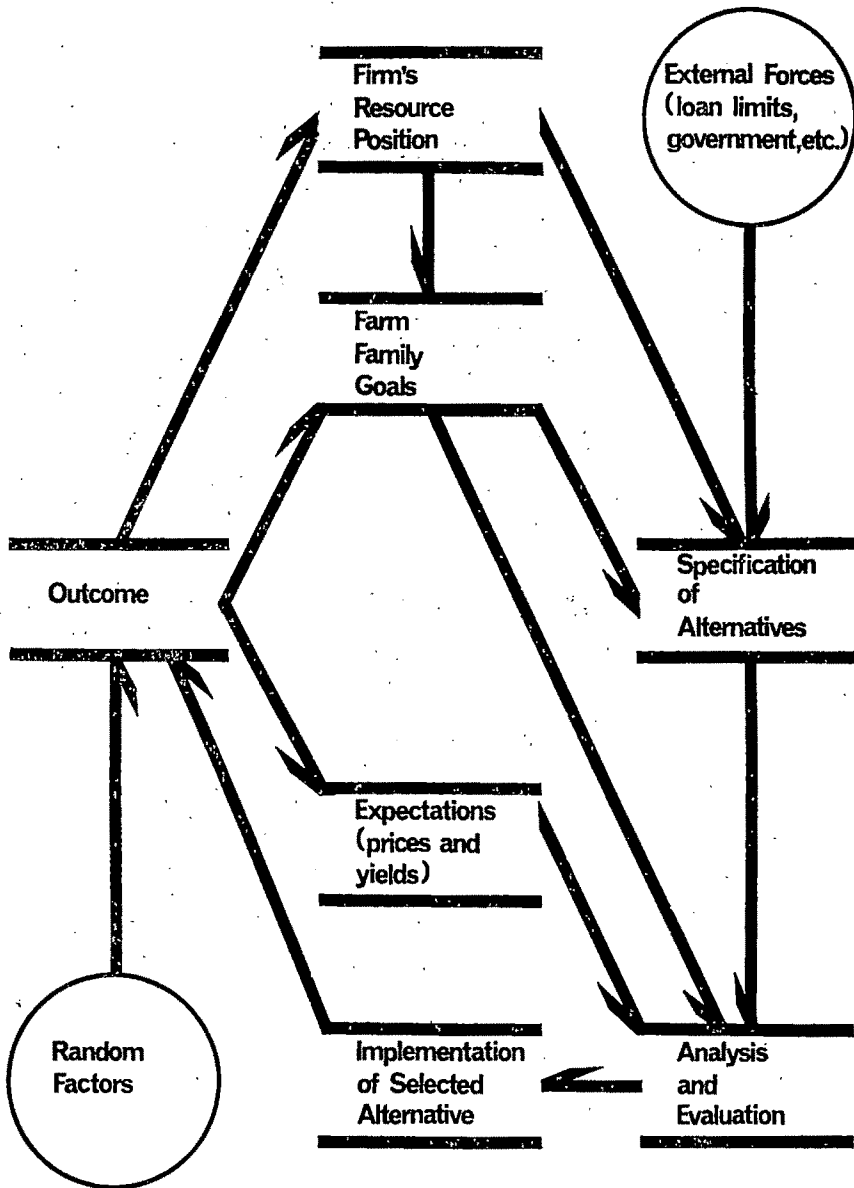


Figure 1. Major elements of a behavioral theory of the farm firm

The specific model of the farm firm

We constructed a simulation model, using the conceptual model of Figure 1 and empirical findings of previous research. For purposes of this study, managerial ability of the farm operator and the capital structure

were controlled variables. The relationships among goals, expectations, and other endogenous dynamic variables were specified in the model.

Farm family goals.—A review of several studies of farm family goals led to the conclusion that goal orientation of farm families could be grouped into four major areas: living standard; farm ownership; leisure-children; and credit-using, risk-taking behavior [8, 14, 16, 18, 26]. *Living standard* is interpreted as the desire for current income to provide a satisfactory level of consumption. *Farm ownership* refers to the desire to own land and accumulate net worth. *Leisure-children* is interpreted as the desire for leisure time and a family. *Credit-using, risk-taking behavior* is the willingness to sacrifice security or accept risk in the farm operation in order to achieve other goals. The relative importance of these goals is influential in determining what alternatives (for example, farm organization, land purchase, off-farm work) a farm family will consider.

The relative importance of farm family goals changes over the course of time as the endogenous dynamic variables of the model change. Major variables affecting the relative importance of these goals are age of the farm operator, net worth, size of farm, and size of family [20]. Four equations were developed to estimate the relative importance of farm family goals on the basis of these four variables.¹

¹ On the basis of survey information in "Goals and Goal Achievement of Central Indiana Farmers," an unpublished paper by L. M. Eisgruber and J. L. Hesselbach, the following multiple regression equations were estimated:

- (1) $G_1 = 2.074 + 0.796 C_1 + 5.625 C_2 + 5.838 C_3 + 0.001 C_4 - 0.669 C_5$
 $- 0.22 \times 10^{-3} C_7 - 0.009 C_1^2 - 0.522 C_2^2 - 0.24 C_3^2$
 $- 0.139 \times 10^{-4} C_4^2 - 0.11 \times 10^{-3} C_5^2 + 6.947 \times 10^{-7} C_7^2$
- (2) $G_2 = -4.115 - 5.504 C_2 + 8.762 C_3 + 0.002 C_1 - 0.017 C_6 + 0.001 C_7$
 $+ 1.135 C_2^2 - 0.323 C_3^2 - 0.292 \times 10^{-6} C_4^2 + 0.332 \times 10^{-4} C_5^2$
 $- 0.595 \times 10^{-7} C_7^2$
- (3) $G_3 = 3.054 - 0.349 C_1 + 1.268 C_2 + 8.144 C_3 - 0.018 C_6 - 0.63 \times 10^{-3} C_7$
 $- 0.34 \times 10^{-4} C_8 - 0.5 \times 10^{-3} C_1^2 - 0.357 C_2^2 - 0.715 \times 10^{-4} C_3^2$
 $+ 0.0001 C_6^2 + 0.783 \times 10^{-7} C_7^2 - 0.043(C_5 + C_6)$
- (4) $G_4 = 60.268 + 7.906 C_2 - 6.068 C_3 + 0.356 C_5 - 0.968 C_2^2 + 0.273 C_3^2$
 $+ 0.316 \times 10^{-7} C_7^2 + 0.122 \times 10^{-9} C_8^2 - 0.003 C_9^2$

where

- G_1 is the score for the living-standard goal (the sample arithmetic mean is 57);
- G_2 is the score for the farm-ownership goal (the sample arithmetic mean is 47);
- G_3 is the score for the leisure-children goal (the sample arithmetic mean is 44);
- G_4 is the score for the credit-using and risk-taking goal (the sample arithmetic mean is 44);
- C_1 is the age of the farm operator in years;
- C_2 is the stage of the family life cycle, coded as follows: 1—no children; 2—all children under 14 years of age; 3—some children over 14; 4—some children over 21; 5—all children over 21;
- C_3 is years of formal education of farm operator;
- C_4 is off-farm income in dollars;
- C_5 is the total number of acres rented;

Consumption.—Farm income is not available in its entirety for reinvestment in the farm business. Regardless of the success of the farm operation, at least a minimum amount of money must go for family consumption. Consumption expenditures of the farm family increase as income increases; family size and age of the operator also affect consumption expenditures [2, 25]. Consumption expenditures are likely to remain relatively constant and to lag in adjustment to changes in farm income [27].²

Expectations.—Expectations form the link between the present and the future in the economic world. Research findings [13, 21, 24, 29] indicate that farmers tend to project the recent past into the future with only minor modification. In line with these research findings, this model considers short-run price and yield expectations to be a function of the past three years' experience of the farmer. Last year's experience is weighted 70 percent; two years ago, 20 percent; and three years ago, 10 percent. Long-run expectations with respect to prices and yields are the mean of the past three years' experience.³

Farm planning.—In farm planning, the model requires the farmer to go through three phases: specification of a plan, budgeting, and evaluation of the expected outcome.⁴ Alternatives considered by the decision maker are determined, in part, by the relative importance of goals held by the farm family and by the firm's resources. The first decision to be

C_6 is the total number of acres owned;

C_7 is taxable farm income in dollars;

C_8 is net worth in dollars; and

C_9 is (total debts/total assets) $\times 100$.

² The following consumption function, which was designed to take these considerations into account, was incorporated in the simulation model. This function is based on USDA data [25, pp. 70, 73, and 76].

$$C = -3277 + 0.5 AFI + 1870 FS + 84.5 AGE - 183.4 FS^2 - 1.1 AGE^2,$$
 where

C is consumption expenditures;

AFI is average farm income after taxes and debt payments (farm income in time period t is weighted by 0.2, $t-1$ by 0.5, and $t-2$ by 0.3; these weights introduce a lag and smoothing of consumption expenditures);

FS is size of farm family ($FS \leq 5$); and

AGE is age of farm operator.

Minimum family consumption expenditures permitted in the model were \$2,000 per year.

³ None of the studies mentioned gives the actual weights to be assigned to the past experiences for purposes of forming expectations. However, these same studies were interpreted as not being opposed to numerical weights such as those indicated here.

⁴ The "farmer" is a submodel of the overall model. That is to say, relationships specifying the farm family goals, the consumption function, formulation of expectations, etc., and their relationship to the decision process are a formal part of the model. Hence, the model (as manipulated by the computer) specifies alternative plans and budgets, and evaluates these plans without interference on the part of the researcher.

made by the farmer is that regarding land acquisition. The importance attached to the farm-ownership goal determines whether a farmer will consider land purchase or renting, both, or neither. Either capital or labor may restrict land purchase.⁵ If the farmer cannot or does not want to buy land, he can rent it on a fifty-fifty crop-share lease if labor is available.

Seven crop rotations of different intensities are specified in the model, and the farmer selects the most satisfactory plan, given existing livestock. With livestock, existing facilities and labor will be used where possible. A plan requiring an investment in livestock buildings will not be considered unless previous alternatives considered do not appear satisfactory. If the farmer is unable to find a plan which satisfies him, he can work off the farm and operate as a part-time farmer or sell the farm.

The decision process.—The farmer budgets each alternative considered, using the price and yield expectations which he has formulated for the coming year. The four goals discussed previously are the criteria by which the expected results of the alternative being considered are evaluated.

The model has a norm for each of the four goals. For the living-standard goal, there is a level of family consumption expenditures which the farmer wishes to attain. This level is a function of past incomes, size of the family, age of the operator, and relative importance of the living-standard goal. The norm for the farm-ownership goal is an increase in the net worth of the farm, and this desired increase is a function of previous net worth. The days of operator's labor available is the norm for the leisure-children goal, and the norm is a function of the farmer's age and the importance of this goal. The magnitude of losses, in view of various prices, relative to the farm net worth is the norm for the risk-taking, credit-using behavior goal.

A level of satisfaction is assigned to each plan, reflecting the degree to which the plan is expected to attain the desired norm.⁶ The typical farmer was assumed to weight the achievement of various goals as follows: living standard, 0.40; farm ownership, 0.25; leisure-children, 0.10; risk-taking, credit-using behavior, 0.25.⁷ The level of satisfaction with respect to a

⁵ It is assumed in this model that land is available for rent or purchase during all time periods. This planning procedure parallels the procedure encountered most often empirically by Chastain [4], but it is not the only one followed by farmers.

⁶ For example, if the farmer in the model has a consumption goal of \$5,500 and a plan will provide \$7,000 for consumption, it is considered a highly satisfactory plan and will be given a satisfaction level of 4. If a plan provides \$5,500 for consumption, it is satisfactory and is given a satisfaction level of 3. A plan supplying over \$4,500, but less than \$5,500 is only partially satisfactory and receives a 2. Plans providing less than \$4,500 for consumption are not satisfactory and score 1. Similar procedures are followed for the other goals. See Patrick [20, pp. 45-46] for details.

⁷ None of the relevant studies reviewed [8, 14, 18, 26] gave actual weights to be assigned to individual goals in order to arrive at an index of overall satisfaction. The order of importance of the goals in these studies was not considered inconsistent with

goal is multiplied by the weighting of the goal, and the sum of these values for the four goals gives a measure of the overall satisfactoriness of a plan. The plan promising the highest level of overall satisfaction—that is, the one which best attains the multiple goals of the decision maker—is selected and implemented in the farm business.

Outcomes of the implemented alternative.—The outcome of a particular decision is computed by a farm-operation simulator.⁸ The requirements of machinery, buildings, fertilizer, feed, labor, and capital are calculated. Crop yields are calculated, capital items are depreciated, the financial results of the farm operation are printed out, and information is updated for another year's decision making. The entire cycle of evaluation of the firm's resource position, revision of goals, formulation of expectations, and planning can now be repeated.

Additional variables and relationships.—Federal income tax, with its progressive structure, may have a major impact on a farmer's ability to increase net worth. Hence, this variable was explicitly taken into account, and the farmer's taxable income for a particular year (as defined by the Internal Revenue Service) was taxed at rates approximately equal to those specified by the Internal Revenue Service for 1964.

Price cycles and trends in crop and livestock yields likewise affect capital accumulation and were explicitly considered. The specific parameters used were derived from time-series data for central Indiana.

Other variables which influence capital accumulation are random variability of outcomes, stage in the price cycle when the model is started, and inflation. Although the model used provides for these features, their explicit consideration was beyond the scope of this study.

The Farm Firm Simulated

A hypothetical farm firm, representative of farms operated by young central Indiana farmers, was used as the initial position for this study.⁹ The hypothetical farmer was a 28-year-old high school graduate, was married, and had three children. As a part owner of his operation, he owned 80 acres of land and rented an additional 120 acres on a fifty-fifty crop-share lease. Labor could be hired, but neither partnership nor incorporation possibilities were considered.

The hypothetical cropping system for the year preceding the analysis was 130 acres of corn, 30 acres of wheat, 30 acres of soybeans, and 10

the numerical weights indicated here. The weightings of the goals in evaluation of a plan were adjusted to reflect the differences in relative importance of particular goals if they differed from those of the typical farmer. For adjustment procedures, see Patrick [20, p. 97].

⁸ This subroutine is a modification of that found in Eisgruber [7].

⁹ The hypothetical farm firm is based on information obtained from Bottum [1], Brake and Wirth [8], and Taylor [23].

acres of hay/pasture. There was sufficient machinery in the form of two tractors, a combine, a corn planter, a corn picker, and a baler to work this operation. The farmer owned 10 brood sows and 20 beef cows. He also had 3 concrete floors (1,000 square feet each), 20 individual farrowing houses, 2 pole barns (1,000 square feet each), and 3 grain bins (1,000 bushels each). Table 1 presents the initial financial situation of the farm firm.

Table 1. Initial financial resources of the simulated farm^a

Type of asset	Total value	Outstanding loan
Land (80 acres)	\$27,600	\$11,040
Buildings	5,480	2,700
Machinery	8,000	4,900
Livestock	6,000	5,000
Cash	2,000	—
	<u>\$49,080</u>	<u>\$23,640</u>

^a Net worth (total value of assets minus total outstanding loans) is \$25,440.

In the past, the cash income of the hypothetical farm has averaged \$5,000 per year.¹⁰ The net worth of the farm firm has increased about \$3,000 per year, and the operator has a 52-percent equity in the farm business. Debt payments of \$7,339 were due during the first year of the analysis.

Specific Situations Simulated

The controlled variables for this study were managerial ability of the farm operator and capital structure. Managerial ability of the farm operator was expressed by the technical transformation rates.¹¹ The crop and livestock yields for the operator with average managerial ability were, in the model, assumed to be approximately equal to the average yields of central Indiana farmers. Yields for the above-average manager were 10 percent higher, and those for the below-average manager were 10 percent lower.

Capital structure was divided into three parts: interest rate, long-term loan limit, and intermediate-term loan limit. Long-term loan limits relate to loans of more than ten years; intermediate-term limits refer to loans of from one to ten years.

¹⁰ Cash farm income in this model is defined as the total receipts minus current operating expenses, federal income taxes, and debt and interest payments. Thus, it is the money available for family consumption and investment.

¹¹ It is hypothesized that managerial ability has several components; however, only the particular component affecting technical transformation rates was considered in this study. See Johnson *et al.* [11] for a broader discussion of managerial ability.

An unlimited amount of credit was assumed to be available for a one-year period to finance current expenses.

Three levels of each of the four controlled variables were simulated. Hence, we considered high, average, and low levels of managerial ability; interest rates of 3, 6, and 9 percent; long-term loan limits of 40, 60, and 80 percent of the value of the asset; and intermediate-term loan limits of 60, 75, and 90 percent of the value of assets with a life of less than ten years.¹² All 81 combinations of these situations were simulated over a 20-year period. The resulting information was then used to analyze the effects of managerial ability, loan limits, and interest rate on the change in net worth, land acquisition, total indebtedness, and family consumption.

Although interest rates, loan limits, and managerial ability of the farm operator were the only controlled variables, they were not the only variables affecting outcomes. Because of the interactions among controlled variables, decisions made, goals, expectations, and outcomes, it is not possible to analyze the effects of controlled variables without also taking into account the relationship between expectations and outcomes and the changes in farmers' goals over the course of time.

Results

Effect of managerial ability

Managerial ability of the farm operator was the major factor, among those considered in this study, determining the rate of growth of the farm firm. With approximately the same level of operating expenses, the better managers had more money available to make debt and interest payments while at the same time providing more money for family consumption and savings. The above-average manager increased his net worth approximately \$2,000 per year faster than farmers of average managerial ability. The more rapid increase in net worth built the base upon which the farmer could borrow, and allowed him to acquire land earlier. Low-level managers could not make the debt payments required by the purchase of land and at the same time maintain a level of family consumption which was considered satisfactory in this study.

Effect of interest rate

The main effects of an increase in the interest rate were to reduce the amount of money available for family consumption and savings and to lower the rate of net worth accumulation. In general, an increase in the

¹² Neither the range of interest rates nor the range of loan limits can claim to be very "practical." But use of these extreme values does focus attention on the influence of the respective restrictions on outcome. The loan limits can be interpreted as either external or self-imposed.

interest rate from 3 to 9 percent reduced the net worth accumulated over the 20-year period about \$30,000, or 17 percent. Increasing the interest rate tended to force the farmer of low managerial ability to go out of farming earlier. Higher interest payments reduce the money available for family consumption expenditures below an acceptable level. Higher interest rates also tend to force the farmer of average managerial ability out of business under liberal loan-limit situations.

Effect of long-term loan limits

The limits on long-term loans determined the timing of acquisition of land. The sooner the farmer was able to buy land, the greater was his net worth accumulation in the model. The farmer of average managerial ability was retarded more by lowering the long-term loan limit from 80 to 60 percent than was the farmer of high managerial ability. The 40-percent long-term loan limit substantially retarded the acquisition of land for farmers of both average and high managerial ability. With high long-term loan limits, family consumption expenditures were lower during the early years of farm operation, but higher in later years, than with low long-term loan limits.

Effect of intermediate-term loan limits

In most instances, the intermediate-term loan limits did not have a major influence either on net worth accumulated by farmers or on other goals. With a high limit on long-term loans, the intermediate-term credit limit did not have much influence on the farm firm. Refinancing long-term loans provided a cushion of credit availability which allowed the farmer to circumvent intermediate-term credit limitations. With lower long-term loan limits and also lower intermediate-term loan limits, a larger net worth was accumulated during the 20-year period by those farmers who shifted toward more extensive crop rotations which require less machinery, retained the livestock enterprises, or acquired more land than by those who shifted to intensive crop rotations. A more complete calculation of the seasonal labor and machinery requirements would have tended to reduce the net worth accumulation of these farmers.

Table 2 presents the net worth status of farmers under different situations at the completion of simulation.¹³

Validity of Results

The results were obtained from a model which is complex relative to the more traditional models in that it takes explicit account of such items as multiple goals, the consumption function, and formulation of expecta-

¹³ For a more complete discussion of these results see Patrick [20, Chap. 4].

Table 2. Terminal net worth status of case farms, in thousands^a

Loan limits (in percentage of value of assets)		Final net worth of farmers with									
Long term	Intermediate term	Low managerial ability					Average managerial ability				
		3%	6%	9%	3%	and with interest rates of	6%	9%	3%	6%	9%
80	90	Sold 7th 34	Sold 2nd 18	Sold 1st 19	Sold 8th 53	Sold 9th 53	Sold 3rd 20	Sold 10th 67	231 ^f	197 ^a	Sold 10th 67
	75	Sold 7th 34	Sold 2nd 18	Sold 1st 19	Sold 8th 53	Sold 9th 54	Sold 3rd 20	Sold 10th 67	232 ^g	197 ^a	Sold 10th 67
	60	Sold 7th 34	Sold 2nd 18	Sold 1st 19	Sold 8th 57	Sold 9th 54	Sold 3rd 20	Sold 10th 67	232 ^g	197 ^a	Sold 10th 67
60	90	Sold 8th 35	Sold 2nd 18	Sold 1st 19	164 ^b	Sold 11th 60	Sold 3rd 20	181 ⁱ	204 ^h	184 ^b	
	75	Sold 5th 30	Sold 2nd 18	Sold 1st 19	165 ^c	156 ^d	Sold 3rd 20	178 ^m	205 ⁱ	184 ^b	
	60	Sold 5th 29	Sold 2nd 18	Sold 1st 19	160 ^d	Sold 5th 33	Sold 3rd 20	170 ^b	203 ^h	184 ^b	
40	90	Sold 9th 24	Sold 8th 25	Sold 8th 24	108 ^b	101 ^e	Sold 18th 53	125 ^a	173 ^j	149 ^b	
	75	Sold 8th 26	Sold 8th 25	Sold 8th 24	108 ^b	100 ^d	Sold 10th 33	124 ^b	162 ^c	134 ^b	
	60	Sold 7th 26	Sold 8th 25	Sold 8th 24	Sold 18th 63	Sold 8th 32	Sold 6th 28	124 ^b	151 ^b	150 ^k	

^a A statement such as "Sold 7th, 34" means that derived consumption levels, debt payments, etc. could not be met and the farm was sold during the seventh year of operation, at a net worth of \$34,000.

^b 400 acres, no livestock. ⁱ 400 acres, 4 sows, 80 feeder cattle.

^c 397 acres, 150 feeder pigs. ^j 477 acres, no livestock.

^d 398 acres, no livestock. ^k 400 acres, 10 feeder cattle.

^e 398 acres, 10 feeder cattle. ^l 400 acres, 25 feeder cattle.

^f 478 acres, 4 sows, 85 feeder cattle. ^m 398 acres, 2 sows.

^g 478 acres, 150 feeder pigs, 45 feeder cattle. ⁿ 478 acres, 10 feeder cattle.

^h 400 acres, 4 sows, 72 feeder cattle.

tions. Failure to model true relationships and/or to aggregate the interrelationships properly could easily go unnoticed, influence the results, and render them useless. Also, the lack of reliable coefficients could make the results less meaningful. Hence, some test of the validity of the results is necessary.

One such test might be to compare the results with the existing theory of firm growth. However, such a theory is poorly developed. Only self-contained and largely unrelated models exist [10, 15, 19, 28]. Insofar as these can be applied to this study, it can be said that the results of this study are in agreement with existing principles and models of investment and firm growth with respect to the influence of managerial ability, interest rates, and credit limitations.

An empirical test of the validity of the results would be to compare the results generated by the model with actual cases. This poses difficulties, since the justification for using a model of this type is that actual cases are not available. In real world situations so many variables are uncontrolled that analysis of historical records of farm firms is exceedingly difficult and highly subjective. Hence, the simulation results can be validated on a basis of "real cases" in only a limited way.

One way in which such validation may be attempted is through comparing the rates of return in the model with actual rates of return. Table 3 presents the simulation model's rates of return on capital for selected combinations of controlled variables.

Table 3. Rate of return to total assets and net worth of case farms over 20 years of operation

Farm situation ^a	Return to total assets ^b	Return to net worth ^b
Average-level manager	Sold	Sold
80% long-term loan limit	5.8%	9.3%
60% long-term loan limit	3.8%	7.1%
40% long-term loan limit		
High-level manager		
80% long-term loan limit	7.8%	10.4%
60% long-term loan limit	6.8%	10.2%
40% long-term loan limit	5.8%	8.5%

^a With the intermediate-term loan limit at 75 percent and a 6-percent interest rate.

^b This rate of return, when applied, will discount the value of the firm's total assets or net worth by the end of 20 years of operation to the value of the firm's initial assets or net worth.

A limited comparison of the simulated results (in Table 3) to actual cases indicates that at least the rates of return on total capital invested are as nearly alike as can be expected under most circumstances. The rate of return on total capital for all Indiana crop farms was 6.9 in 1962 and

7.2 in 1963. The 1950-1959 average was 5.0 percent. In 1963, the average rate of return on investment in large crop farms was 9.4 percent on the "most profitable" group and 3.7 percent on the "least profitable." In 1964, earnings were 4.8 percent on all crop farms [22].¹⁴ Thus, there is at least limited evidence to suggest that the results obtained from this simulation of farm firm behavior have a satisfactory degree of validity.

Economic Implications

This study indicates that enterprise management ability of the farm operator (technical transformation rates) is a major factor in determining the rate of growth of the farm firm. High levels of technical efficiency will result in high levels of farm income, net worth accumulation, and the possibility of higher levels of consumption. Farmers of high managerial ability appear to have fewer forced sales and a more efficient use of resources than those with less managerial ability. Improvement of the technical rates of transformation by 10 percent increased the farmer's net worth about \$2,000 per year or about 25 percent at the end of the 20-year period. Investments made by the farmer to improve his managerial skills appear to have potentially high returns.

The extent of capital rationing (either external or internal) is also important to the growth of the farm firm. Long-term loan limits are important in determining the rate at which the farm firm can expand; thus they determine the time by which an economically productive farm size can be attained. External long-term loan limits must reflect the managerial ability of the farm operator if they are to be nonlimiting. Liberal credit policies may allow the farmer of low managerial ability to expand beyond his capacity to make debt and interest payments while maintaining an acceptable level of family consumption expenditures; on the other hand, restrictive credit may seriously impede the progress of high-level managers.

While the interest rate does have some effect on the amount of net worth accumulated by the farmer in 20 years, its real influence appears to be on the ability of the farm business to survive the early years of operation. The interest rate was a twofold influence during these years. First, a low rate of interest reduces the interest and debt payments a farmer must make and, second, it permits the farm family to maintain a satisfactory level of consumption expenditures. Most of the additional income resulting from a low interest rate is consumed and thus has less influence on net worth accumulation than either managerial ability or loan limits.

This analysis indicates that farmers with "average" or "low" managerial ability and assets similar to the initial situation in this study can remain in farming during the early years of farm operation only by reducing con-

¹⁴ The rate of return to net worth is not calculated for the Indiana farms [22].

sumption expenditures below the normally desired levels. The low-level manager does not achieve the level of satisfaction to which he aspires during early years of farm operation and, from the lending institutions' viewpoint, he automatically becomes a poor credit risk because he can make debt payments only by reducing his consumption. Even a short sequence of low-income years can lead to bankruptcy.

The initial situation of the farm firm in this study was quite favorable. However, in order to achieve a rate of growth of the type required for ownership of a commercial-sized farm, the farmer was forced to go into debt "to the limit." The liquidity position of the firm at this point is critical. This study clearly indicates that, with increasing capital requirements of a farm business, the problem of intergeneration transfer of farm capital becomes very important.

A starting farmer, of unproven managerial ability, would require equity capital of about \$45,000 and a debt commitment of around \$75,000 to obtain a commercial farm without renting, taking traditional loan limits as given. Continued transfer of such amounts of capital through inheritance appear, in general, unlikely. This study indicates that servicing debts of this magnitude with interest rates higher than 3 percent is possible only for above-average managers. All this points to the need for studies of different financing arrangements, changes in institutional conditions of farm transfer, and the possibilities and effects of separating farm operators and ownership of farm assets.

Research Implications

This study points out some of the possibilities of a relatively new research method in the study of decision making and farm firm growth. The model does not have the formal elegance of more traditional methodology, nor the ease of application to a variety of specific farm firm problems. However, this study shows that simulation models can be used to approximate the farmer's decision-making process with reasonable accuracy. Assumptions of profit maximization and perfect knowledge do not have to be made and noneconomic costs and returns can be included with relative ease. The attention of the researcher can be focused on specific intrafirm relationships. The researcher can change key factors in these relationships, while holding other factors constant, and can study the results. The time paths of variables are known, whereas in standard linear-programming and marginal-analysis models only the equilibrium positions are known.

Simulation procedures appear to be well suited to the study of one factor while others are held constant. They make it possible to isolate the effect of changes in one variable on a variety of other variables. As a research tool, simulation is limited only by the researcher's imagination. If

specific data are not available, a relationship can often be approximated on the basis of available information. "Sensitivity analysis" on certain coefficients can be made with relative ease and at low cost by simulation techniques.

The objectives of the study were not to find optimal strategies of farm firm growth in the face of risk and uncertainty. However, the basic model readily lends itself to such a study. An evaluation of such an approach relative to various programming models [17] would undoubtedly yield useful information of theoretical as well as pragmatic interest.

The review of literature associated with construction of this model in the areas of farm family goals, formulation of expectations, planning, decision making, and satisficing versus maximizing suggests that considerable work has been done in these areas, but this research lacks consistency and contiguity. Efforts to achieve contiguity appear useful and desirable, since the complex interrelationships of these areas appear to be the essence of firm behavior.

The implications of the behavioral approach to descriptive and normative analyses of individual firms for aggregates of these firms are not easy to see at this stage. We think that we have shown that this approach can be valuable for descriptive economic analysis. We have further suggested that it would be relatively easy to use this approach to yield optimal strategies, that is, to expand into normative analysis. If the problem of calculation can be solved, it is possible that this approach may be useful in the analysis of problems at an aggregate level. The ideas offered in this article can be only a small indication of the possible, and may encourage more empirical and analytical work with this orientation.

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Credit in the Production Organization of the Firm*

C. B. BAKER

It is argued that the equilibrium conditions traditionally used by economists must be modified to provide criteria for optima useful to the firm. Important modifications are associated with liquidity attributes of the firm organization. Credit, defined as borrowing capacity, constitutes an important source of liquidity. Accordingly, borrowing generates a cost from loss of liquidity as well as from interest charges on loans. Modifications are suggested in the relevant optimizing criteria relating to the firm to account for liquidity losses associated with borrowing. Finally, the modifications are reflected in models and observational techniques suggested to make the conceptual notions operationally useful.

EACH firm has a financial component as well as nonfinancial components. The financial component includes claims held and debts owed, values reported in a balance sheet of the firm. A less evident part of the financial component is liquidity of the firm: access to financial assets and terms on which such access may be gained. Profit-seeking managers are willing to pay for liquidity in more or less tangible terms. The most tangible, perhaps, is found in insurance. The second is in choices made that favor liquid relative to illiquid assets and flexibly managed debts relative to inflexible debt commitments. A third is in reservation of "credit"—credit defined as the capacity to borrow. Unused credit, like balance sheet assets that are liquid, constitute a reserve of liquidity that can be called upon to counter the effects of failure in expectations. Though not included in the balance sheet, liquidity also has value.

In this article, I outline the effects of liquidity value, in the form of "credit," on production organization of the firm and stress the fact that the values are attached to the unused portion of "credit." To exchange credit for a loan generates a cost in the tangible form of interest. The exchange also entails a loss of liquidity. How costly it is to lose liquidity depends upon the total credit available to the entrepreneur and alternative sources of liquidity. In any event, I argue that "credit" is an asset which can be managed—made to grow, decline, and change in structure—and that the results are important for production organization of the firm.

* Ideas contained in this article were assembled in seminars which I conducted at the Universities of Sydney, Melbourne, Adelaide, and Western Australia (Perth) and Australian National University in 1967. However, their origin is in research conducted earlier at the University of Illinois. Thanks are due especially to G. D. Irwin, D. E. Neuman, and L. F. Rogers for early testing of the utility of the notion of lender preferences and to staff and students at the various universities for criticisms on the broader frame of reference in which this article is cast. Finally, I am grateful for comments from two anonymous *Journal* reviewers.

The Theory of Production Organization

Let

$$(1) \quad y = y(x_1, x_2/x_f)$$

be a single-valued continuous function with continuous first- and second-order derivatives, defined for non-negative values of y (output) and x_i (input). The quantities y and x_i are rates of flow per unit of time. If time, implicit in the relation, is less than infinite, x_f (input constant with respect to y) is positive. The level of y with respect to x_1, x_2 is influenced by the value of x_f and the technology used in production. The rate at which x_1 substitutes for x_2 is given by

$$(2) \quad S_{1 \text{ for } 2} = - \frac{dx_2}{dx_1},$$

which is economically relevant only where dx_2/dx_1 (and dx_1/dx_2) ≤ 0 . The locuses of points where $dx_2/dx_1, dx_1/dx_2 = 0$ are "ridge lines." The ridge lines bound the economically relevant area of the production surface mapped with isoquants.

Let the cost of production be given by

$$(3) \quad c = p_1x_1 + p_2x_2 + b,$$

where p_i is the price of x_i and b the cost of x_f . We define an "iso-cost" line as the locus of input combinations that can be bought for a given outlay. Specifying c as a parameter,

$$(4) \quad c^0 = p_1x_1 + p_2x_2 + b,$$

we solve for

$$(5) \quad x_1 = \frac{c^0 - b}{p_1} - \frac{p_2}{p_1} x_2$$

and

$$(6) \quad x_2 = \frac{c^0 - b}{p_2} - \frac{p_1}{p_2} x_1.$$

The first term on the right side of (5) and (6) defines maxima of x_1 and x_2 , respectively, that can be bought at outlay c^0 . The ratio p_1/p_2 defines the slope of an iso-cost line. On assumption that the price of input is constant for quantities bought, for all inputs, the iso-cost line is straight as between all pairs of inputs.

The output, y , is maximized, given c^0 , on the condition,

$$(7) \quad -\frac{dx_2}{dx_1} = \frac{p_1}{p_2}.$$

Since y^0 and c^0 are parameters, both can be shifted. A locus of points generated by (7) is called an expansion path with respect to x_1, x_2 , with the special property that it defines cost-minimizing combinations of x_i for given levels of y .¹ It can be expressed as an implicit function:

$$(8) \quad s(x_1, x_2) = 0,$$

for which (7) is satisfied.

Among other uses, (8) can be used to appraise organizations in terms of "efficiency," since it traces a path of maximum economic efficiency, as defined above. A combination of x_1, x_2 that fails to meet condition (8) is thus judged to be less than maximally efficient.

Financing Inputs

We retain the simplifying assumption that the firm is a pure competitor in the purchase of x_1 and x_2 . However, we drop the assumption, implicit in the above summary, that the firm contains within its own resources the capacity to purchase x_1 and x_2 without limit. That is, the purchase of x_1 and x_2 must be financed with loan funds. Hence, the optima specified in (7) must now be respecified:

$$(9) \quad -\frac{dx_2}{dx_1} = \frac{p_1 + F_1}{p_2 + F_2},$$

where F_i is the marginal cost of finance for each unit of x_i . If the ratio F_1/F_2 equals the ratio p_1/p_2 , there is no diminution of efficiency, in the sense of departure from the expansion path. There may, of course, be a failure to reach an optimum rate of output, depending on whether or not the expected lender response to total loan requests constrains the final production organization.

Assume that the lender is expected to favor x_2 over x_1 . The discrimination can take either of two forms. The rate of interest may be lower on a loan to finance x_2 than it is on a loan for x_1 . In this case, the consequence is clear. The numerator in the right-hand term of (9) increases relative to the denominator, thus increasing the value of the right-hand term. To retain the equality requires an increase in the left-hand term: x_1 must be reduced relative to x_2 . The more likely lender response, however, is more

¹ To assure that (7) yields a cost *minimum* requires that $\gamma^2 y / \gamma^2 x_i > 0$, a condition that cannot be safely neglected in the presence of production complementarities among inputs.

subtle. Suppose that the lender charges the same effective rate of interest, whatever the use of funds. But the loan limit to finance x_1 is less than the loan limit to finance x_2 . That is, credit of the firm is absorbed at a rate that is greater for x_1 than it is for x_2 . If we assume that credit remaining unused has a value greater than zero, F_1 exceeds F_2 and the optimum quantity of x_1 will be reduced relative to x_2 .

In Figure 1, the cost of producing y^0 is minimized with x_1^1 and x_2^1 when it is assumed that the effect on credit is the same per unit of either input. OS_1 traces the path of cost-minimizing combinations on this assumption. On the other hand, should the farmer expect lenders to favor x_2 over x_1 , the expansion path will steepen (see, for example, OS_2). The path of cost-minimizing combinations will reflect different combinations of x_1 and x_2 in equilibria. The cost of producing y^0 will be increased from c^0 to c^1 .

Similar results hold in the allocation of resources among competing uses. Given that products y_1 and y_2 are each produced optimally (that is, on expansion paths, respectively), it can be shown that inputs *common to both products* are optimally allocated between the products when

$$(10) \quad -\frac{dy_2}{dy_1} = \frac{P_1}{P_2},$$

where P_1 and P_2 are prices of y_1 and y_2 , respectively. If the firm is a pure competitor in the sale of products, the slope of the "iso-revenue" line, defined by the right side of (10), is a constant.

This rather limited optimum can be extended easily by accounting for the marginal cost, with respect to output, of inputs specific to each product:

$$(11) \quad -\frac{dy_2}{dy_1} = \frac{P_1 - C_1}{P_2 - C_2},$$

where C_1 and C_2 are marginal costs, with respect to output, of inputs specific to production of y_1 and y_2 , respectively. Equation (11) specifies an optimum allocation of *all* resources: those specific as well as those common to y_1 and y_2 . We have assumed, in Figure 2, that the modified iso-revenue function is also linear. The assumption may be violated by nonlinear production relations or by input prices that vary with respect to quantities purchased. However, our analysis is facilitated by the linearity assumption and our conclusions little affected by its failure if it can be further assumed that any nonlinearity is convex with respect to the origin.

However, suppose that (a) the firm is dependent upon loan funds to finance the expansion of y_1 and/or y_2 and (b) available lenders discrim-

inate, favoring y_2 over y_1 . That is, credit absorbed to finance y_2 is less than credit absorbed to finance y_1 . Under these conditions, an optimal allocation of variable inputs between y_1 and y_2 requires

$$(12) \quad -\frac{dy_2}{dy_1} = \frac{P_1 - [C_1 \pm L_1]}{P_2 - C_2 \pm L_2},$$

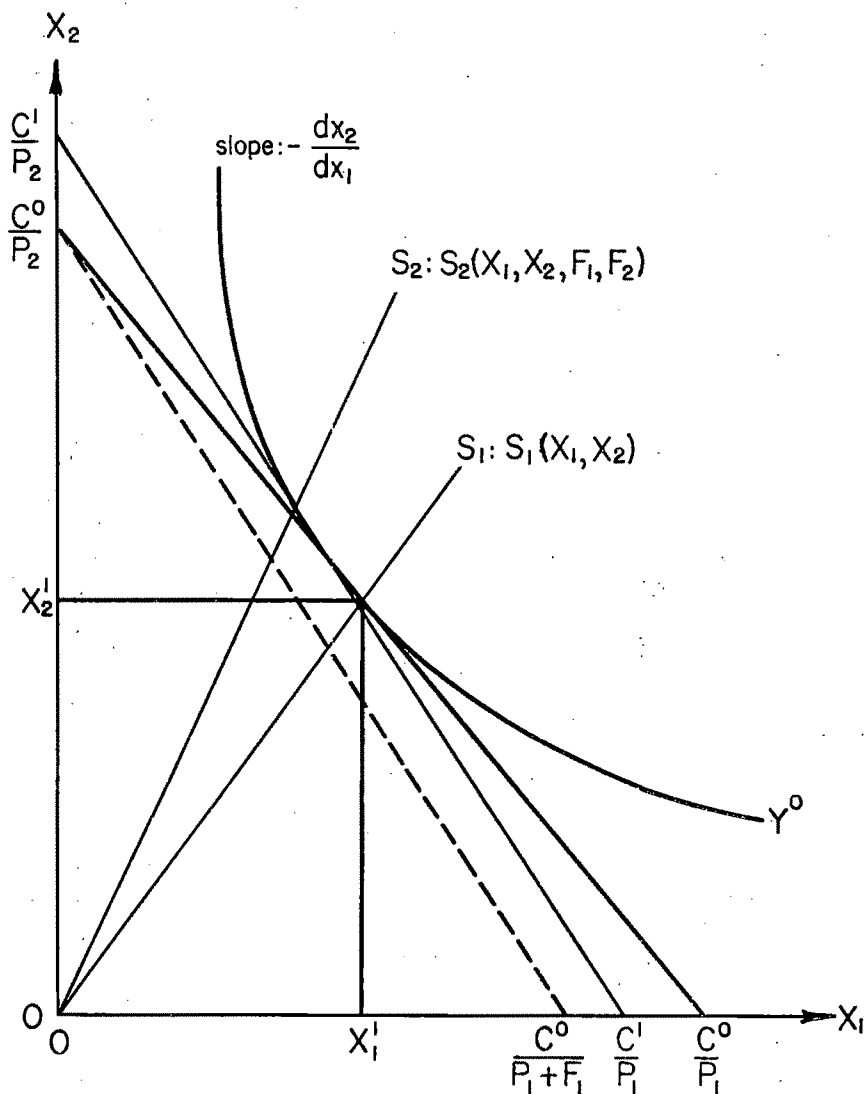


Figure 1. Effects of finance costs on cost-minimizing combinations of X_1 and X_2

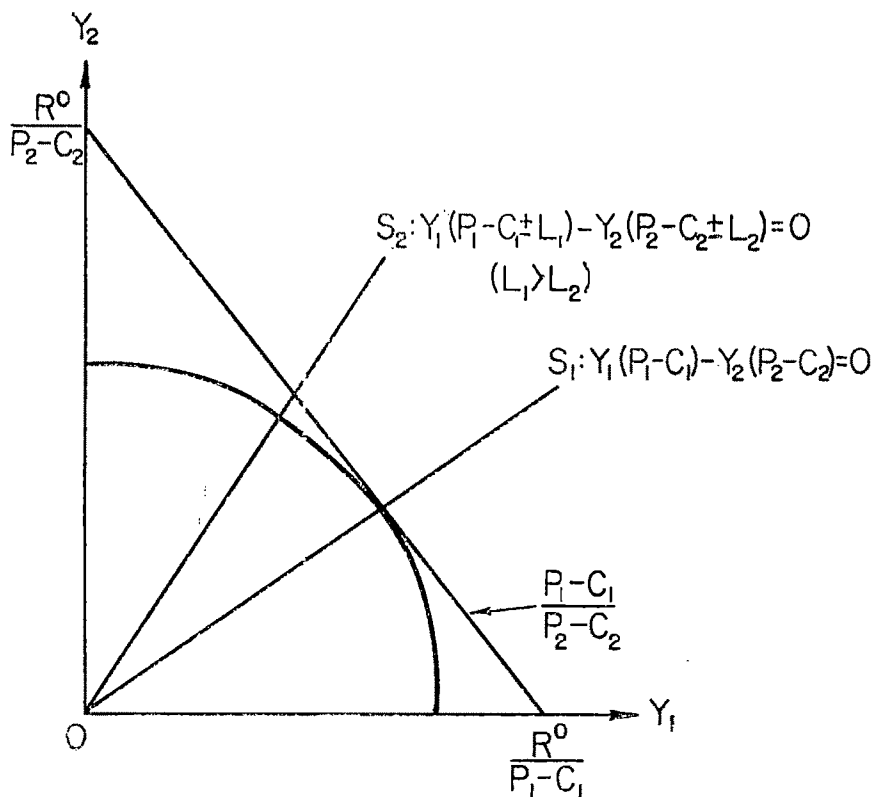


Figure 2. Effects of finance costs on profit-maximizing allocations of resources between Y_1 and Y_2

where L_i is a general term, expressing the cost to the firm associated with credit absorbed in borrowing, in terms of output. We associate this cost with loss of liquidity occasioned by borrowing. Again, if credit held in reserve is worth anything greater than zero, y_2 will be increased relative to y_1 .

We conclude that an optimal response of the borrowing firm to lender preferences generates a production organization that is suboptimum if a market-oriented theory of the firm is taken as the source of criteria for optima. An exception is noted if lender preferences happen to accord with market preferences. That is, should F_1/F_2 in (9) equal p_1/p_2 , lender preferences would not affect the slope of the iso-cost function and hence would leave the optimally adjusted production organization on expansion path OS_1 (Fig. 1). Similarly, in the case of resource allocation, y_1 and y_2 would be produced along OS_1 (Fig. 2) if L_1/L_2 happened to equal $(P_1 - C_1)/(P_2 - C_2)$.

Little research has been done to discover lender preferences.² Yet the available evidence suggests that there is little relation between market preferences and lender preferences. Nor do lenders appraise expectations in the same terms as borrowers. Presumably, the latter are influenced by relative contributions of alternatives to net income (and determinants thereof). Evidence suggests that lenders favor loans that are self-liquidating or asset-generating or both. Neither characteristic necessarily coincides with market preference or borrower preference. Hence, for prescriptive purposes, the model of production organization implied by a market-oriented theory of the firm must be adapted to the behavioral properties of lenders and the response thereto of the firm's entrepreneur.

Research Implications

To explore the implications of these adaptations of the theory of the firm's production organization, it is convenient to represent the choices and constraints thereon in terms of submodels of linear programs. In Table 1, we outline four choices among many open to the firm: buy machinery (M) or livestock (S) and use machinery or livestock. The choices are constrained by a sum of cash, shown in the column of constraint levels. The objective is to maximize returns above variable cost, where the profit-contributing activities are from use of machinery and use of livestock. The relative contributions to profit (Pr) are 1.8 and 1.5 dollars per unit of activity from use of machinery and livestock, respectively.

In so simple a choice, it can be seen immediately that the optimum choice is to use machinery to the maximum permitted by the cash constraint. To vary cash parametrically would in no case generate a qualitatively different solution. The use of machinery would simply be made to vary.

In Table 2 we elaborate both alternatives and constraints to include the possibility of (and constraints on) borrowing to finance purchases of machinery and livestock. The consequence is to add a column to reflect the

² Findings reported by R. K. Lindner [3] agree largely with some aspects of research findings of my own.

Table 1. Submodel of a linear program: no external finance

Row description	Buy		Use		Relation	Constraint level
	M	S	M	S		
Cash	1	1			\leq	b_1
Machinery	-1		1		\leq	0
Livestock		-1		1	\leq	0
Profit			1.8	1.5	$=$	max

Table 2. Submodel of a linear program: undifferentiated external finance

Row description	Buy		Use		Borrow	Relation	Constraint level
	M	S	M	S			
Cash	1	1			-1	\geq	b_1
Machinery	-1		1			\leq	0
Livestock		-1		1		\leq	0
Credit					a	\leq	b_2
Profit			1.8	1.5	-1.06	$=$	max

activity of borrowing and repaying the debt incurred and a row in which to reflect the credit limit (b_i in constraint level) available to the firm.

A more realistic portrayal would, of course, permit borrowing to occur throughout the period (say a year); it would also permit loan balances to be repaid through the period, and loans activated later in the year to be carried forward into the following period (or represent unpaid debt as reduction in profit). We retain maximum simplicity in Table 2 while introducing the bare essentials related to finance.

With the assumption that credit of the firm is undifferentiated as to use or source of loan funds, we see immediately that the submodel represented in Table 2 will generate qualitatively the same choices as does the one in Table 1. The addition of an undifferentiated credit constraint affects, in general, the quantity in which M is activated, but not the relation between M and S in the optimum solution.

In Table 3, we introduce differentiated credit, a suggestion of a "credit profile." It is a simplified version, of course, when compared with its likely complexity in the real world. Yet simple as it is, it has properties that allow us to explore consequences of financial constraints and alternatives on production organization. An additional column is required, as well as an additional row, to reflect the difference in rate at which credit of the firm is absorbed in financing M or S. No special empirical significance should be ascribed to the credit coefficients in these columns. Yet they do

Table 3. Submodel of a linear program: external finance differentiated by purpose of loan

Row description	Buy		Use		Borrow		Relation	Constraint level
	M	S	M	S	M	S		
Cash	1	1			-1	-1	\geq	b_1
Machinery	-1		1				\leq	0
Livestock		-1		1			\leq	0
Credit					2.0	1.2	\leq	b_2
Profit			1.8	1.5	-1.06	-1.06	$=$	max

reflect evidence at hand on the *relative* absorption rates for loan purposes thus differentiated. Given these credit absorption rates, we now find that the optimum production organization depends on the value of credit held in reserve.

In Table 4 we add the realistic element of credit differentiated by source of loan, in the case of machinery, as well as use made of loan proceeds.

Table 4. Submodel of a linear program: external finance differentiated by loan purpose and source of loan

Row descrip- tion	Buy		Use		Borrow			Rela- tion	Con- straint level
	M	S	M	S	M		S		
					B	D			
Cash	1	1			-1	-1	-1	\geq	b_1
Machinery	-1		1					\leq	0
Livestock		-1		1				\leq	0
Credit (3)					a_B	a_B^D	a	\leq	b_2^B
Credit (2)					a_D^B	a_D		\leq	b_2^D
Profit			1.8	1.5	$-(1+i)$	$-(1+i)$	$-(1+i)$	$=$	max

In the credit rows, we show, with subscripts, coefficients that reflect credit absorption rates associated with the source from which the loans are obtained. Coefficients with superscripts reflect reaction of the alternate lender to borrowing from his competitor. They are in the nature of interaction terms and would likely be so estimated in regression models used to estimate such coefficients.

We have introduced but a sample of elements that are relevant from the financial environment external to the farm firm. For example, the problem of sequential alternatives cannot be accommodated in the simple submodels we have used so far. For intrayear sequential alternatives, there must be a specification of subyear periods—for example, quarters, months, or other time periods. Another alternative is leasing (or hiring) resources or actual job contracts. These alternatives too would likely require that the model period be divided into subperiods. The effects of lease choices on credit would be reflected in values of technical coefficients in the body of the tables.

Multiperiod Effects

Further developments follow. The most obvious is to introduce alternatives in the acquisition of land resources: purchase, lease, or development of resources already at hand. With choices already illustrated, a model with multiple time periods would be most useful. For treatment of alter-

natives in real property, it becomes imperative. The alternatives in models are multiperiod linear programming, recursive linear programming, dynamic programming, and simulation. For reasons outlined elsewhere [1], I have chosen multiperiod linear programming for its versatility.

Table 5 displays an abbreviated version of a submodel with the necessary additions. Land is designated by L , divided into two (quality) classes (subscripts), and measured in physical units (say, acres). To buy adds land in the period of purchase (superscripts) and in each succeeding period as well. To lease, on the other hand, adds land only in the period of the transaction. We show land improvement to be permanent, like land purchase. However, the effects of an alternative assumption could be shown quite easily. An initial land supply is specified in right-hand elements in each of the periods in which the model is specified. The initial cash supply is specified for the first period only, supplies for succeeding periods being made available through transfer, in addition to cash generated in each of the periods from sales.

We have not shown consequences of the land transactions and use on credit and borrowing alternatives. Clearly, the relevant credit profile is now enlarged to include farm mortgage credit as well as non-real estate credit. The terms of farm mortgages and land leases might well be expected to affect non-real estate credit limits and rates of use consequent to borrowing. Hence, a new array of coefficients needs now to be estimated.

The inclusion of land improvement as an alternative to purchase and lease suggests immediately the desirability of adding a further submodel reflecting the tax consequences. We have not done so, but the problem does not appear to be intractable from a logical point of view, and the observational problems that are generated are simple compared to others implied by the adaptations suggested above.

Observational Problems

Observational problems also are implied. In the submodel displayed in Tables 3 and 4, it is clear that each of the parameters identified with a letter constitutes a task in estimation. In summary, what is required is an estimate on total credit available from alternate sources, in whatever categories it is relevant to make differentiations, and rates at which such credits are absorbed (or generated) by financial, production, and marketing activities.

The first point is elementary. Since the parameters describe lender behavior, the observational target is the relevant population of lenders. It would be a misallocation of research resources, therefore, to survey farmers in (say) an attitudinal study of credit use. It would not be irrelevant, however, to study decision-making processes and behavior of farmers,

Table 5. Submodel of a multiperiod linear program: alternatives in acquisition of land resources^a

Row description	Add land						Add land						Use		Sell		Transfer cash		Relation	Constraint level
	Buy			Lease			Improve	Buy			Lease			Improve	Use		Sell		1-2	2-3
	L ₁	L ₂	L ₃	L ₁	L ₂	L ₃		L ₁	L ₂	L ₃	L ₁	L ₂	L ₃		L ₁	L ₂	L ₁	L ₂		
L ₁ ¹	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	1					
L ₂ ¹	a	a	a	a	a	a	a	a	a	a	a	a	a	a					1	
C ₁ ¹																				
L ₁ ²	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	1		1			
L ₂ ²																				
C ₂ ²																				
L ₁ ³	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	1		1			
L ₂ ³																				
C ₃ ³																				

^a Coefficients labeled *a* and *b* are required to be estimated.

to test the relevance of a model of the type illustrated in Table 4. The model generates an equilibrium that is joint among production, financial, and marketing choices. To me, such a portrayal of alternatives and constraints (and objective) is an appealing assumption on the behavior most farmers would regard as economically desirable. Yet the point is controversial enough that research is needed to resolve it.

To obtain relevant estimates on lender response is a subtle problem. For many years, lenders have been counseled to appraise loan requests of farmers on the basis of their effects on profit to the farmers. Were one to make an attitudinal survey of responsible lending officers, he might well conclude that such a lending criterion is indeed a principal feature of lender behavior. Yet there are persuasive reasons to suspect that the commercial lender would be foolish to follow such a criterion without substantial modifications.

First, his return from a loan consists of a fixed sum, given time, that is quite small relative to the principal sum that is advanced. Unlike the farmer, the lender does not participate in profit expectations. Second, the lender often is asked to finance the purchase of a long-term asset with a short-term loan. Hence, the payoff period that is relevant to the lender differs from the payoff period relevant to the borrower. Finally, the lender's behavior is constrained by determinants of his supply of loanable funds. And these differ from the determinants of the farmer's demand for loan funds. Hence, it is naïve to expect the lender to possess the same set of behavioral responses to production and marketing alternatives as does the farmer.

One way of avoiding the problem of conditioned response of the lender is to study loans actually made by lenders, and factors associated with variations in terms of the loans. Such an approach is limited relative to informational requirements of models such as those we have illustrated. At best, data available are restricted to loans that have been approved. The information required includes loan *limits*. Also, the loan requests themselves reflect inhibitions of farmers in making loan applications. One strongly suspects that for many farmers the fear of possible rejection keeps them from asking for loans, thus truncating the distribution of loan requests that might otherwise be observed.³

A second way to avoid the problem of lenders' conditioned responses might be to simulate a borrowing situation. We have, in fact, been reasonably successful in several simple simulations in studies of commercial lenders in Illinois [2]. The simulations require formulations of a farm description, in terms of a list of assets, debts, income and expenses, and a

³ Support for this hypothesis can be found in results of a survey of Australian farmers made by the Australian Reserve Bank in 1965 [4, p. 19].

family situation. In one example, it was realistic enough that several respondents thought they recognized the farm among their customers! The interviewer was a graduate student with a farm background, whose age was the same as that postulated for the farm operator. After introducing himself to the loan officer and applying for a loan, he drew on the descriptive information as required to respond to questions asked by the loan officer. The loan application was made at a level designed to be almost certain to generate a refusal, whereupon it was lowered until an acceptance was gained. The process was repeated over several loan purposes, and among different types and locations of lenders. The results could be summarized in terms of what might be characterized as the firm's "credit profile."

We found primary lenders (banks and production credit associations) to prefer loans that are (1) self-liquidating and (2) asset-generating. In the Midwest, cattle feeding loans possess both properties and, in addition, are administratively convenient and large in size. They are highly valued loans and represent the only instance in which we could detect a concession in terms of interest rate. Otherwise, the rate of interest appeared to be unsuitable as an instrument with which to reflect degree of risk, at least over the range of risk tolerated by the primary lender.

A self-liquidating loan is one in which the proceeds are so used that the payoff occurs within the maturity of the loan. An example is a one-year loan for nitrogenous fertilizer. An asset-generating loan is one in which the proceeds are used to add an asset that can be formally pledged as a lien in support of the loan. A machinery loan has this property. A fertilizer loan does not. Lenders varied in their ranking of loans with one but not the other property. In general, however, such loans were viewed much less favorably than were those with both properties. Since the evidence was available in terms of loan limits, the types of loans could be differentiated in numerical terms, as required by properties of the model.

We have since expanded the research to explore the effects of varying the sequence of borrowing activities. We have found, for example, that credit available to the farmer within a year is larger if he finances first a cattle purchase and later a machinery investment than if he were to reverse the sequence. We have done little to examine the possibility of interaction between lenders. Again the sequence of events may be important. The primary lender may so react to a debt already owed to a merchant that the farmer's total credit is reduced. But the reverse almost certainly is not so. The dealer seldom so reacts to the existence of a debt owed to a primary lender. He is highly specialized, as a lender, confined to the merchandising transaction that gave rise to the demand for a loan in the first instance. Moreover, the lien commonly is restricted to the asset whose purchase is being financed.

Concluding Remarks

Earlier I argued that to use credit entails a loss of liquidity. Since liquidity is valuable, credit use is costly. To estimate the cost requires (1) relevant and accurate estimates on amounts of liquidity loss and (2) cost rates to associate with liquidity loss. We have shown that the first requirement can be satisfied by (a) appropriate estimates of lender behavior and (b) incorporation of such estimates in allocation decisions within the credit-using firm.

We have said little of empiric relevance with respect to the second requirement. One possibility is to examine costs of liquidity sources alternative to credit, such as insurance, cash, and forward contracts. Insurance and forward contracts are less general than credit, however, and their costs perhaps, therefore, an underestimate of the liquidity value of credit. On the other hand, cash is still more general than credit, as a source of liquidity. The cost of cash withheld from production commitment might therefore represent an overestimate of the liquidity value of (unused) credit.

Were relevant and accurate estimates available on such liquidity values, they could easily be incorporated in allocation models such as those indicated in this article. They simply would be used (as reservation prices) in slack vectors, to value credit in its various forms. One might expect relevant reservation prices to vary widely among firms and over the course of time for a given firm. Useful results might be obtained from ranging them as parameter variations in linear programming applications.

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The Long-Run Efficiency of United States Sugar Policy*

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The adequacy of future sugar availabilities for United States consumption requirements since the 1960 embargo on Cuban sugar is a matter of continuing concern. This article gives estimates of the long-run effects of this embargo on the world and the United States sugar economies as well as of the efficiency of current United States long-run sugar supply policy. Long-run supply and demand functions were estimated and a general equilibrium competitive model was constructed. Comparison of the results of this competitive model with projected results of the present United States sugar supply program demonstrates the potential economic inefficiencies of the program.

THE mid-1960 embargo on Cuban sugar closed off a source which had supplied over one-third of the United States' total consumption requirements for some years. The conditions of the embargo and later changes in the Sugar Act of 1948 include a quota for Cuba, but this quota has been reallocated to other sources until Cuba returns to the free world. The uncertainty of this return gives rise to continuing concern about the adequacy of future overall supply of sugar to satisfy domestic consumption requirements [7, p. 1].

The reallocation of the United States sugar quota has had marked long-run effects on the source pattern. In addition, the mutually dependent acts of setting a long-run sugar policy and specifying supply sources must carry out the purposes of our present Sugar Act¹: (1) to make it possible, as a matter of national security, to produce a substantial part of our sugar requirements within the United States and to do this without a highly protective tariff, (2) to assure United States consumers of a plentiful and stable supply of sugar at reasonable prices, and (3) to permit nearby friendly foreign countries to participate equitably in supplying the United States market for the double purpose of expanding international trade and assuring a stable and adequate supply of sugar [8, p. 2].

However, these goals are being achieved at the expense of higher consumer prices and inflexibility in quota allocations, so that development of new and perhaps lower-cost supply regions is retarded.

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¹The Secretary of Agriculture has responsibility for administration of the Sugar Act(s).

The 1960 embargo decision and the politically oriented policy of inducing artificially high prices to encourage domestic production are interrelated, but they are distinct issues. Although both affect the efficiency of the United States supply pattern—and the world sugar market as well—our analysis will attempt to isolate the Cuban embargo effect from the remaining determinants of the efficiency of this market.

The purpose of the research reported in this article was to estimate the long-run effects of the Cuban embargo on the world sugar economy and on the United States and to estimate the efficiency of current United States long-run sugar supply policy. This efficiency was measured by comparing the total cost of obtaining the long-run United States supply under conditions imposed by United States sugar legislation with costs under conditions of a more competitive world market.

Recent History of United States Sugar Programs

The present basic Sugar Act of the United States was passed in 1948. This Sugar Act made provision that the domestic areas (United States mainland, Hawaii, Puerto Rico, and the Virgin Islands) and the Philippines be granted fixed sugar tonnage quotas which would not vary with changes in consumption requirements, as determined by the Secretary of Agriculture. For Cuba and other foreign countries, the quotas were fixed on a percentage basis, Cuba receiving 98.34 percent and other countries 1.36 percent of the difference between consumption requirements and the sum of the fixed tonnage quotas for the domestic areas and the Philippines. This arrangement allocated substantially all of the increase in United States consumption requirements to Cuba.

A 1951 amendment to the Sugar Act increased the fixed quota for Puerto Rico and the Virgin Islands, increased the quota for foreign countries other than Cuba and the Philippines from 1.36 to 4 percent, and set Cuba's share at 96 percent. A 1956 amendment restored to the domestic areas participation in the growth of the United States market. That is, any growth in United States consumption beyond 8.35 million short tons was shared 55 percent by domestic areas and 45 percent by foreign areas.

The July 1960 amendments to the Sugar Act provided for presidential actions under which sugar imports from Cuba were effectively terminated.² The diverted quota was allocated according to the following provisions:

1. To domestic areas, Cuba's former share in domestic area deficits.³

² The United States severed diplomatic relations with Cuba in January 1961.

³ A *deficit* refers to the inability of a country to supply its quota under the Sugar Act. This refers to both domestic and foreign sources. The 1960-1962 amendments required that if he discovered that any domestic area or Cuba could not supply its quota, the Secretary of Agriculture must allocate the deficits among the rest of the

Table 1. United States domestic sugar supply allotments^a

Area	Prior legislation	Sugar Act of 1948 as amended, 1962	Sugar Act of 1948 as amended, 1965
	<i>.....short tons, raw value^b.....</i>		
Domestic beet area	2,110,627	2,650,000	3,025,000
Mainland cane area	649,460	895,000	1,100,000
Hawaii	1,117,936	1,110,000	1,110,000
Puerto Rico	1,231,682	1,140,000	1,140,000
Virgin Islands	16,795	15,000	15,000
Total	5,126,500	5,810,000	6,390,000

^a These allotments are based on consumption requirements of not over 9.7 million short tons in 1962 nor over 10.4 million short tons in 1965. See footnote 4 regarding allocation of consumption requirements in excess of these figures in the 1962 and 1965 amendments.

^b Raw value of any quantity of sugar means its equivalent in terms of ordinary commercial raw sugar testing 96 degrees by the polariscope. The rate for converting values from raw to refined is 100 parts to 92 parts.

Sources: U.S. Congress [5], U.S. Senate [9].

2. To countries having quotas of 3,000 to 10,000 tons, enough to permit total imports of 10,000 tons from each.

3. To the Republic of the Philippines, 15 percent of the remainder after the first two provisions are effected.

4. The balance, including deficits in above, to other quota countries in proportion to quotas regularly determined.

5. Amounts not forthcoming from sources in provision four, to any friendly foreign country [6, p. 8].

Amendments passed in March 1961 required special consideration in making importations under the fifth provision to countries in the Western Hemisphere and to countries purchasing United States agricultural commodities. In July 1962, the Sugar Act of 1948 was amended and extended to December 31, 1966. In November 1965, the Sugar Act was again amended and extended to December 31, 1971. As shown in Table 1, both the 1962 and 1965 amendments increased the quotas for sugar allocated to domestic sources.⁴

areas in proportion to their quotas. The 1965 amendment assigned a share amounting to 47.52 percent of all deficits beginning in 1966 to the Philippines, except that a deficit of a country which is a member of the Central American Common Market would first be allocated to other member countries. The remainder of deficits arising in a domestic area or any Western Hemisphere country would be prorated to other Western Hemisphere countries. The remainder of deficits arising elsewhere would be prorated to other non-Western Hemisphere countries.

⁴ Table 1 shows the allotment of sugar supply to United States domestic sources under consumption requirement assumptions of 9.7 million short tons in 1962 and 10.4 million short tons in 1965. Table 2 indicates the percentage allocation to foreign sources of the difference between total domestic allocations shown in Table 1 and these consumption requirements, less allocations to the Philippines and other special sources as mentioned elsewhere.

In the 1962 amendment, the Republic of the Philippines was given a quota of 1.05 million short tons. In the 1965 amendment, to this quota of 1.05 million short tons was added 10.86 percent of an amount, not to exceed 0.7 million short tons, by which the requirements for consumption for the calendar year, as determined by the Secretary of Agriculture, exceeded 9.7 million short tons. In both amendments, small allocations were also made to the United Kingdom, Belgium, and Hong Kong in 1962 and to Ireland and the Bahama Islands in 1965.

Both amendments reallocated the Cuban share. Under the 1965 amendment, the 50-percent Cuban share was prorated among those other foreign countries listed in Table 2 according to their basic quotas until such time as Cuba's quota is restored following its return to the free world. However, the portion of the Cuban share arising from consumption requirements in excess of 10 million short tons is to be prorated among members of the Organization of American States.

The Long-Run Efficiency of the World Sugar Economy

For my purposes it was necessary to estimate long-run (through 1970) demand and supply functions for the supplying and/or consuming regions (Table 3) and to estimate transportation costs.⁵ Although few data were available for this purpose, I used what seemed to be the most reliable information available at the time.

Long-run supply estimates⁶

I calculated linear supply functions for some 38 major free-world sugar suppliers, using quantities of sugar that a USDA study [7] estimated would become available under different price situations relative to 1959 prices. For the supplying countries not in the USDA study, supply functions were assumed which are infinitely elastic at 1959 prices up to a quantity estimated to be the country's long-run capacity. At this capacity, the function has zero elasticity. For the following reasons, this functional form was considered to be appropriate for the countries involved:

1. Many of the countries for which this particular function was used are temperate, high-cost, sugar-beet areas of Western Europe, Eastern Europe, the U.S.S.R., and Communist China. The production policies of most of these countries are based on meeting domestic consumption needs rather than on exports. Increases in sugar production for the U.S.S.R. and Communist China in the near future will likely be confined within the limits of their domestic consumption requirements.

⁵ Cost equations for ocean transportation of sugar in 1959 and 1963 are developed in my original study [1, pp. 148-166].

⁶ The derivation of the long-run supply and consumption estimates are dealt with in more detail in the original study [1, pp. 83-107].

Table 2. Individual foreign country quotas^a

Country	Sugar Act of 1948 as amended, 1962	Sugar Act of 1948 as amended, 1965	
		With Cuban share	Cuban share reallocated ^b
		.....percent.....	
In Western Hemisphere			
Cuba	57.77	50.00	—
Mexico	6.71	7.73	15.46
Dominican Republic	6.71	7.56	15.12
Brazil	6.37	7.56	15.12
Peru	6.71	6.03	12.06
British West Indies	3.19	3.02	6.04
Ecuador	0.88	1.10	2.20
French West Indies	1.06	0.95	1.90
Argentina	—	0.93	1.86
Costa Rica	0.88	0.89	1.78
Nicaragua	0.88	0.89	1.78
Colombia	—	0.80	1.60
Guatemala	0.71	0.75	1.50
Panama	0.53	0.56	1.12
El Salvador	0.36	0.55	1.10
Haiti	0.71	0.42	0.84
Venezuela	—	0.38	0.76
British Honduras	0.35	0.22	0.44
Bolivia	—	0.09	0.18
Honduras	—	0.09	0.18
Paraguay	0.35	—	—
Outside Western Hemisphere			
Australia	1.41	3.60	7.20
Republic of China	1.24	1.50	3.00
India	0.71	1.44	2.88
South Africa	0.71	1.06	2.12
Fiji	0.35	0.79	1.58
Thailand	—	0.33	0.66
Mauritius	—	0.33	0.66
Malagasy Republic	—	0.17	0.34
Swaziland	—	0.13	0.26
Southern Rhodesia ^c	—	0.13	0.26
Netherlands	0.35	—	—

^a Quotas represent relative shares of United States sugar requirements remaining over the allocations to domestic sources, the Philippines, and other exceptions as stated in each amendment.

^b Assuming United States consumption requirements of not over 10 million short tons.

^c Withheld in 1965.

Sources: U.S. Congress [5], U.S. Senate [9].

2. Several of the cane-producing countries are low-income, developing, tropical African countries which, as a general rule, have balance-of-payments problems. They are dependent upon the foreign exchange which they can earn, borrow, or get through grants or aid for the importation of capital equipment with which to implement their economic development programs. As a result, they often find it advantageous to expand their

Table 3. Geographical regions and departure-arrival ports^a

Region	Port(s)
1. Northwest Europe	Oslo
2. West Europe	London
3. North Central Europe	Danzig
4. South Central Europe	Trieste
5. Regions 3 and 4 combined ^b	Trieste
6. U.S.S.R.	Odessa
	Leningrad
7. United States	New York
	New Orleans
	San Francisco
8. North America	Montreal
	Vancouver
9. Central America and Caribbean	Santo Domingo
9a. Cuba	Habana
10. Western South America	Callao
11. Eastern South America	Recife
12. Northwest Middle East	Izmir
13. Western Middle East	Al Basrah
14. Middle East	Colombo
15. North Far East	Yokohama
16. North Middle Far East	Shanghai
17. China (Taiwan)	Tanshui
18. Middle Far East	Penang
19. Philippines	Manila
20. South Far East	Djakarta
21. South Africa	Durban
22. Central Africa	Mombasa
23. East North Africa	Port Said
24. Southwest North Africa	Lagos
25. Northwest North Africa	Casablanca
26. Indian Ocean	Port Louis
27. Australia	Brisbane
28. Fiji Islands	Suva
29. New Zealand	Wellington
30. Hawaiian Islands	Honolulu
31. Southern Oceania	Papeete
32. U.S.A.-administered Oceania	Apra
33. New Guinea and Western Samoa	Port Moresby

^a All distances between ports were calculated for use in the solution of the competitive models.

^b Regions 3 and 4 in 1959 were joined in 1963 to make a single region 5.

sugar production to save the foreign exchange which would otherwise be spent for sugar imports. Such expansion may be undertaken despite high internal costs, and the amount produced may be highly independent of prices in the world market. On the other hand, several African countries are relatively new in sugar production and have abundant lands for this purpose and promising potential for future, competitively priced sugar. Some of them, such as Ghana, Nigeria, Ethiopia, and Sudan, are particularly interested in developing internal sources of supply. The future possibility of competing on the world sugar market could be a strong

incentive for the development of their sugar-producing sections, even at initially high costs.

3. A number of cane-producing countries (for example, Angola, Mozambique, Malagasy, Kenya, Tanzania, and Uganda) produce under administratively contrived price structures and quotas. The sugar exports of these countries go to one of the large consuming countries of Western Europe or onto the world sugar market under the terms of the Commonwealth Sugar Agreement.

The assumed supply functions for these countries imply that, at about the 1959 at-region price for sugar, each of these countries would supply sugar up to its physical capacity. Below this price no sugar would be supplied, as each of the countries would import instead. When the sugar price falls below their 1959 supply price, these countries could shift land into something else for which their costs of production are lower relative to the world price, and export this product in exchange for sugar.

For Cuba, the available data were insufficient to allow construction of a defensible long-run supply curve which showed any price interaction other than infinite elasticity up to capacity. While Cuba sells a significant amount of sugar on the free market, she also has certain politically determined supply commitments which are not closely related to price.

In estimating long-range capacity limits, I considered such factors as available land for future expansion, present and estimated constraints on future growth of milling capacity and technology, growth in yields per acre, government policy regarding the role of sugar production in each country's overall economic performance, age and condition of present sugar lands, and climate. For the United States, Puerto Rico, the Virgin Islands, and Hawaii, estimates were available in the USDA study.

Long-run demand estimates

For purposes of estimating long-run sugar consumption functions, studies by Viton and Pignalosa [10] and the United Nations [3, 4] were very useful. Viton and Pignalosa studied the trends in the consumption of sugar over the last two decades, and the factors determining sugar consumption and its growth rates, and concluded their analysis with some indications of the likely course of sugar consumption in the years ahead. These sources gave me sufficient information so that I could estimate total sugar consumption by certain groups of countries (grouped by per capita sugar consumption) in 1970.

In the Viton and Pignalosa study, price, income, and consumption data were analyzed for 55 to 60 countries through two approaches: (1) cross-correlation of all countries for years 1938, 1951, and 1956, and (2) cross-correlations of groups of countries, classified according to levels of price

or levels of income, for varying numbers of years. One of the interesting results of the analysis was that the coefficients of price and income elasticities were very close—the price elasticity was about the same as the income elasticity. I made the assumption that this close relationship between the income and price elasticity of demand coefficients will continue until 1970.

Estimation procedure used

Given the estimated regional sugar consumption for 1970 referred to above and assuming that these quantities held for 1970 prices (which are equivalent to 1959 prices), I started with each 1959 regional price, assumed a given percentage price decrease, and, with the estimated elasticity coefficient, calculated the increased amount consumed in 1970. It was then possible to calculate linear consumption functions, given price and quantity data before and after the price change.

Using these long-run supply and consumption functions, an estimated ocean transportation cost function, and an iterative general-equilibrium model, I have determined for the world sugar economy (1) the long-run structure of market and product prices that would be consistent with competitive equilibrium, (2) the long-run allocation of producing regions among markets that would accompany such prices, (3) the quantities that would be produced and consumed in each region, and (4) the quantities of product which would be supplied from each producing region to each consuming region under these conditions.

In Model 1, equilibrium prices, supply, and consumption were estimated for 1970 conditions (including Cuba as a source); in Model 2, the same estimates were obtained, using the constraint that no sugar could move from Cuba (Region 9a) to the United States (Region 7).

Table 4 indicates total production and exports by regions for Models 1 and 2 and actual regional figures for 1959 and 1963. In the long-run solution for Model 1, the USSE (Region 6) produces only about one-third of her 1959 level; the United States (Region 7) produces only about 70 percent of her 1959 level; Central America and the Caribbean (Region 9) expand production about 50 percent over 1959; and Cuba (Region 9a) expands production to 9 million metric tons, her estimated productive capacity in 1970.

The results for Model 2, when compared to those for Model 1, indicate that exclusion of Cuban sugar shipments from the United States (1) leads to a small increase in sugar shipped in interregional trade (26,172,000 metric tons in Model 1, 26,401,000 metric tons in Model 2), (2) decreases the world amounts of sugar produced and consumed (61,013,000 metric tons in Model 1, 60,603,000 metric tons in Model 2), and (3) increases all regional absolute prices except those of Cuba (Region 9a) (Table 5).

Table 4. Total production and exports by world regions,^a 1959, 1963, Model 1, and Model 2

Region	Production				Exports			
	1959 Actual	1963 Actual	Model 1 1970	Model 2 1970	1959 Actual	1963 Actual	Model 1 1970	Model 2 1970
	<i>1,000 metric tons</i>							
1	592	634	346	346	6	51	—	—
2	3,912	4,195	4,948	4,949	992	1,126	—	—
3	4,766	^b	6,626	6,626	918	^b	1,683	1,683
4	2,039	^b	2,242	2,242	49	^b	386	386
5	^b	7,573	—	—	^b	89	—	—
6	6,513	5,978	2,057	1,324	215	919	—	—
7	2,559	3,417	1,686	1,866	2	—	—	—
8	132	151	200	200	—	49	—	—
9	4,832	5,242	6,772	6,833	2,654	3,120	4,037	4,118
9a	5,964	3,821	9,000	9,000	4,951	3,520	7,929	7,929
10	1,123	1,415	2,119	2,122	335	509	1,029	1,046
11	4,647	4,774	7,648	7,655	787	1,138	3,040	3,054
12	526	518	921	922	3	33	—	—
13	110	156	—	—	—	12	—	—
14	2,480	2,815	4,809	4,813	17	276	—	—
15	145	375	—	—	9	—	—	—
16	1,260	1,300	—	—	78	169	—	—
17	914	738	1,453	1,457	656	681	1,324	1,332
18	171	106	—	—	3	76	—	—
19	1,514	1,501	2,711	2,727	1,054	1,069	2,040	2,061
20	856	652	1,659	1,659	39	105	987	1,024
21	1,346	1,733	2,168	2,170	358	857	918	923
22	181	253	—	—	—	7	—	—
23	401	470	—	—	—	—	—	—
24	11	26	—	—	—	—	—	—
25	1	5	—	—	17	—	—	—
26	789	920	1,074	1,075	668	802	1,029	1,030
27	1,290	1,706	1,964	1,972	647	1,152	1,239	1,249
28	255	296	363	367	183	262	340	344
30	884	999	247	278	886	937	191	222
Totals	49,938	51,473	61,013	60,603	15,527	16,959	26,172	26,401

^a Regions 29, 31, 32, and 33 are not included because they are not producers of sugar and it is assumed that they will not become so over the long run.

^b Regions 3 and 4 in 1959 were combined into a single region, 5, in 1963. Therefore, there are no Regions 3 and 4 in 1963 nor a Region 5 in 1959.

According to the results of Model 1, the United States produces 1,686,000 metric tons of sugar for its own consumption, and the difference between this amount and 10,763,000 metric tons (U.S. consumption in Model 1) is imported from the Caribbean and Central America, Cuba, and South America (Regions 9, 9a, and 10) at \$102.95 per metric ton (Table 6). Under Model 2, however, the United States domestic production increases to 1,866,000 metric tons, and the difference between this figure and a lower total consumption figure of 10,740,000 metric tons comes from the Caribbean and Central America, South America, Fiji, Australia, and Hawaii (Regions 9, 10, 11, 27, 28, and 30) at \$105.45 per met-

ric ton. This supply pattern and these price changes result in an increase of \$2.50 per ton in the cost of United States sugar consumption.

In Table 5 actual 1959 prices are given, along with the prices obtained from Models 1 and 2. The prices allocated from the models are "shadow" prices or the dual solution to the competitive allocation model. The structure of these regionally competitive prices maximizes the total value of the sugar (that is, the return to suppliers), and the resultant pattern of allocation minimizes the total cost of the sugar to consumers. Long-run competitive conditions would reduce prices in the United States (Region 7), the Philippines (Region 19), Hawaii (Region 30), Mauritius (Region 26), Fiji (Region 28), and Central America and the Caribbean (Region

Table 5. Comparison of estimated prices for Models 1 and 2 with actual 1959 prices^a

Region	1959 prices	Estimated prices	
		Model 1	Model 2
	.....U.S. dollars per metric ton.....		
1	101.13	104.69	104.93
2	96.50	104.39	104.75
3	95.73	101.57	101.57
4	84.94	101.02	101.39
6	79.11	105.35	105.35
7	126.51	102.95	105.45
8	85.42	103.58	103.66
9	107.19	98.58	101.08
9a	94.33	99.08	98.72
10	73.31	97.84	100.34
11	89.20	98.81	99.81
12	76.90	105.06	105.43
13	89.10	104.89	105.58
14	112.04	103.56	104.82
15	81.11	102.90	104.16
16	84.48	102.50	103.76
17	65.62	98.72	99.98
18	94.67	102.86	104.12
19	120.63	98.37	99.63
20	73.39	98.98	100.24
21	102.92	99.09	99.52
22	124.37	103.59	104.02
23	100.72	105.22	105.65
24	142.37	103.73	104.73
25	119.53	104.02	104.45
26	124.77	99.41	100.10
27	80.68	97.13	98.39
28	100.16	97.15	99.21
29	72.41	101.48	102.74
30	133.82	98.67	100.73
31	100.63	101.72	103.76
32	138.44	102.17	103.43
33	151.04	101.37	102.63

^a Actual regional prices were calculated by dividing the total value of sugar shipped from a region in 1959 by the amount of sugar (in metric tons) shipped from the same region.

Table 6. Estimated importance of supply sources in 1970 under amended 1948 Sugar Act

Region	Sugar Act with Cuba		Sugar Act without Cuba		Model 1		Model 2	
	Amount	Per-centage of total	Amount	Per-centage of total	Amount	Per-centage of total	Amount	Per-centage of total
	<i>Quantity of sugar</i>							
	<i>metric tons</i>	<i>per-cent</i>	<i>metric tons</i>	<i>per-cent</i>	<i>metric tons</i>	<i>per-cent</i>	<i>metric tons</i>	<i>per-cent</i>
7	4,319,132	41.800	4,319,132	41.800	1,686,000	15.7	1,866,000	17.4
2	4,854	0.005	4,854	0.005	0	0.0	0	0.0
9	1,745,247	16.900	2,474,935	24.000	119,000	1.1	4,118,000	38.3
9a	1,456,539	14.100	0	0.000	7,929,000	73.7	0	0.0
10	231,008	2.200	498,654	4.800	1,029,000	9.6	1,046,000	9.7
11	261,013	2.500	563,476	5.500	0	0.0	2,274,000	21.2
14	41,948	0.040	65,890	0.060	0	0.0	0	0.0
17	43,696	0.040	68,635	0.070	0	0.0	0	0.0
18	9,613	0.009	15,100	0.010	0	0.0	0	0.0
19	1,021,525	9.900	1,021,525	9.900	0	0.0	0	0.0
21	43,405	0.040	68,177	0.070	0	0.0	0	0.0
26	9,613	0.009	15,100	0.010	0	0.0	0	0.0
27	104,871	1.000	164,725	1.600	0	0.0	870,000	8.1
28	23,013	0.020	56,148	0.040	0	0.0	344,000	3.2
30	1,006,992	9.800	1,006,992	9.800	0	0.0	222,000	2.1
Totals ^a	10,322,400	100.000	10,322,400	100.000	10,763,000	100.0	10,740,000	100.0
	<i>Value of sugar^b</i>							
	<i>1,000 U.S. \$</i>	<i>per-cent</i>	<i>1,000 U.S. \$</i>	<i>per-cent</i>	<i>1,000 U.S. \$</i>	<i>per-cent</i>	<i>1,000 U.S. \$</i>	<i>per-cent</i>
7	606,388	39.500	606,388	39.900	173,574	15.7	196,770	17.4
2	755	0.005	755	0.005	0	0.0	0	0.0
9	449,578	29.300	520,338	34.200	12,250	1.1	434,201	38.3
9a	143,742	9.400	0	0.000	816,211	73.7	0	0.0
10	18,085	1.200	38,946	2.600	105,925	9.6	110,291	9.7
11	21,287	1.400	45,952	3.000	0	0.0	239,771	21.2
14	3,152	0.200	4,952	0.300	0	0.0	0	0.0
17	3,161	0.200	4,965	0.300	0	0.0	0	0.0
18	1,242	0.080	1,950	0.100	0	0.0	0	0.0
19	130,446	8.500	130,446	8.600	0	0.0	0	0.0
21	4,474	0.300	7,028	0.500	0	0.0	0	0.0
26	1,147	0.070	1,801	0.100	0	0.0	0	0.0
27	9,200	0.600	14,451	0.900	0	0.0	91,733	8.1
28	2,448	0.200	3,846	0.300	0	0.0	36,271	3.2
30	139,500	9.100	139,500	9.200	0	0.0	23,408	2.1
Totals ^a	1,534,601	100.000	1,521,314	100.000	1,107,960	100.0	1,132,445	100.0
	<i>Total cost per metric ton</i>							
Average	<i>U.S. \$</i>	—	<i>U.S. \$</i>	—	<i>U.S. \$</i>	—	<i>U.S. \$</i>	—
	148.67		147.39		102.94		105.44	

^a Components may not add to total because of rounding errors.

^b Total landed value (value times transport cost from source regions to the United States plus price at source regions, using 1959 prices) of the trade in the columns showing quantity of sugar.

9). These price reductions occur because Model 1 is a competitive model and thus eliminates the administratively determined high prices in the United States and the United Kingdom.⁷ The more competitive areas such

⁷ World sugar trade can be classified into two categories: (1) free market trade, and (2) trade outside the free market. If that trade which is subject to regulation as to quantity, direction, and price is included in the second category, then this category accounted for about 52 percent of world sugar exports over the period 1954-1962. Such regulated trade includes transactions under the Commonwealth Sugar Agreement, the United States Sugar Act, the French sugar bloc agreement, and the Portuguese sugar bloc agreement [2, Vol. 1, pp. 163-200].

as Cuba (Region 9a), South America (Regions 10 and 11), and Taiwan (Region 17) would have prices above 1959 prices.

Actual 1959 prices are plotted against estimated competitive prices for Models 1 and 2 in Figure 1. The points to the left of the diagonal are for those regions in which the actual 1959 price was lower than the competitive price. These are the regions for which actual 1959 prices were lower than competitive prices estimated for Models 1 and 2 (Table 5). Regions for which actual 1959 prices were above the estimated competitive prices are plotted to the right of the diagonal in Figure 1. If the actual and the estimated competitive prices had exactly coincided, all of the prices would have fallen along the diagonal.

What is most striking about this comparison is the rather substantial pricing inefficiency introduced into the world sugar economy by politi-

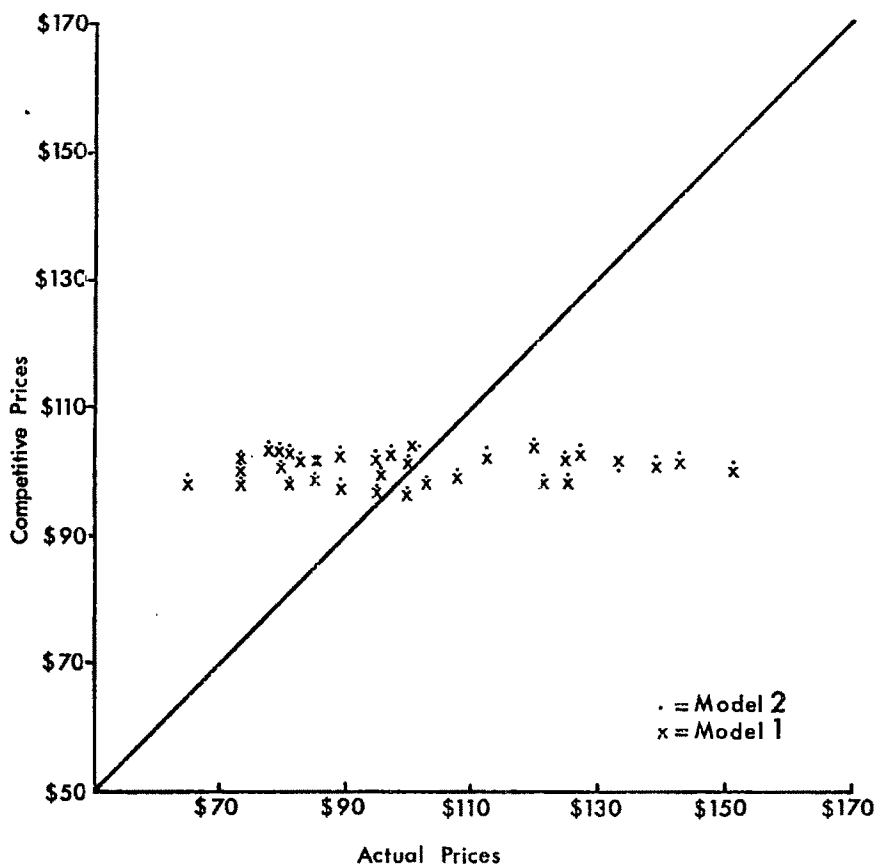


Figure 1. Actual 1959 prices compared to competitive prices estimated from Models 1 and 2, in U.S. dollars per metric ton

cally contrived and supported regional groupings such as the United States sugar bloc, the Commonwealth Sugar Agreement, the French sugar bloc, and the Portuguese sugar bloc. Stated in another way, this analysis indicates that competitive sugar prices among markets of the world would differ much less than do actual politically influenced prices.

The Long-Run Efficiency of the United States Supply Pattern

The United States sugar supply patterns in 1970 under the 1948 Sugar Act as amended in 1965 and under Models 1 and 2 are given in Table 6. As is shown, estimated cost of the United States sugar supply in 1970 under provisions of the Sugar Act if Cuba is included as a source is \$1,534.6 million; under competitive conditions this cost would be \$1,108.0 million, a reduction of about 28 percent. A similar comparison shows that the estimated cost in 1970 under the assumption that the Cuban embargo is still in effect is \$1,521.3 million, and that under Model 2, which also excludes Cuban sugar shipments to the United States, the total cost would fall to \$1,132.4 million, a decrease of about 26 percent.

Table 6 shows that the projected United States sugar supply pattern places heavy emphasis on domestic supply sources. By weight, Region 7 has 41.8 percent of total sugar, whether Cuba is excluded or not; by value, it has 39.5 percent when Cuba is included and 39.9 percent when Cuba is excluded. However, in Model 1 only 15.7 percent of total requirements by weight and value would come from domestic sources, and in Model 2 this figure increases only slightly to 17.4 percent. In other words, in the two competitive models, production of sugar in the United States would drop to less than 2 million metric tons from the more than 4 million metric tons proposed by the latest sugar legislation, which is a drop of 53.7 percent.

The relative inefficiency, when Cuba is omitted, resulting from the present sugar quota allocation of the United States is illustrated in another way in Table 6, where it can be observed that 2.5+ million tons from Region 9 are valued at \$520 million, whereas, under Model 2, 4.1 million tons are valued at only \$434 million. These figures imply prices of about \$200 per ton in the first instance and \$106 per ton in the second. This apparent inconsistency is a result of the underlying regional cost structures. If Cuba is excluded, under the Sugar Act, a large part of the sugar supplied would be from Puerto Rico, which is a high-cost supplier. In the competitive solution under Model 2, the sugar supply would come from the lowest-cost countries in each region.

Table 6 shows that under the present Sugar Act, 16.9 percent of total sugar by weight will come from Region 9 (Caribbean and Central America) in 1970 if Cuba is included as a source, and 24.0 percent if Cuba is excluded; the total cost of sugar from this region is 29.3 percent with Cuba and 34.2 percent without Cuba. Region 9 is relatively a high-cost

region, as is shown by the fact that in Model 1, with Cuba, only 1.1 percent by weight and cost is allocated to Region 9 and in Model 2, without Cuba, the allocation increases to 38.3 percent.

In 1970, the total cost per metric ton in the United States under the present Sugar Act will be \$148.67 if Cuba is included as a source and \$147.39 if Cuba is excluded (about 6.6¢ per pound in each case). If the world sugar economy were efficient in the way that Models 1 and 2 suggest, then the total cost per metric ton would be \$102.94 under Model 1 (4.6¢ per pound), a reduction of 30.3 percent over the actual pattern including Cuba, and \$105.44 under Model 2 (4.7¢ per pound), a reduction of 28.8 percent over the actual pattern excluding Cuba.

Conclusion

The effects of the embargo on Cuban Sugar and the particular reallocations made are significant. These effects include (1) an increase of 10.7 percent in domestic sugar production, (2) a shift in foreign sugar supply sources from nearby countries (the Caribbean, Cuba, Central and South America) to more distant countries (the same sources, minus Cuba, plus Fiji, Australia, and Hawaii), and (3) an increase of \$2.50 per metric ton in the cost of sugar.

Effects of the embargo on the world sugar economy include (1) an increase of 0.9 percent in the total amount of sugar shipped in international trade, (2) a decrease of 0.7 percent in the amount of sugar produced and consumed, (3) an increase of 80.40 per metric ton in the cost of transporting sugar internationally, and (4) an increase in all regional sugar prices except those for Cuba. The analysis also revealed a marked divergence between optimal and actual world regional prices.

The long-run efficiency of current United States sugar supply legislation depends, among other things, on whether or not Cuba qualifies to regain her quota within the United States sugar supply system. Leaving the question of Cuba aside, the actual long-run United States sugar supply program involves considerable inefficiency. The findings of this study suggest (1) that the actual cost, under the Sugar Act, of United States supply in 1970, if Cuba is included as a source, would be 38.5 percent higher than under competitive Model 1; (2) that if the Cuban embargo is still in effect in 1970, the cost, under the Sugar Act, of United States supply would exceed the Model 2 competitive cost by 34.3 percent; (3) that domestic production of sugar in 1970 under present United States sugar legislation will be 4,319,132 metric tons—considerably in excess of the 1,686,000 metric tons of Model 1 and the 1,866,000 metric tons of Model 2; (4) that the total cost per metric ton in the United States, under the Sugar Act supply pattern, would be \$148.67 if Cuba is included and

\$147.39 if Cuba is excluded, compared to costs of \$102.94 for Model 1 and \$105.44 for Model 2.

The research reported here was concerned primarily with economic rather than political efficiency. However, politically optimal policies are not possible unless the economic opportunity costs of proposed programs are known.

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Quadratic Programming Solution of Competitive Equilibrium for U.S. Agriculture*

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A quadratic programming model is applied to the solution of a competitive equilibrium for the field-crops sectors of U.S. agriculture. The analysis is based on nine spatially separated markets, with separate demand functions for six commodities in each. The objective of the programming model is to maximize net profits (total revenue minus production costs, land rents, and transportation costs) derived from satisfying the endogenously determined demand in the various markets. This objective is subject to the constraints on land availability, demand functions, and the competitive equilibrium condition that product price not exceed marginal cost. The empirical results are consistent in the sense that programmed equilibrium prices are considerably lower than actual prices in the base year, 1965. Even under equilibrium at relatively low prices, surplus land is indicated in the South-eastern and Great Plains states. The results suggest the potential for various policy applications, including the analysis of potential short-run prices in the presence or absence of "free market" equilibrium.

GENERAL equilibrium analysis occupies a central place in the interest of earlier economists such as Walras, Pareto, Fisher, Wicksell, and Cassel. More recently, several writers, including Kuenne [11] and Dorfman, Samuelson, and Solow [4] have contributed extensions of these earlier works. The latter have emphasized the relationships between linear programming and general equilibrium. Substantive empirical investigations, however, had to await the development of large-capacity computers. Even then, most investigations to date have treated only one economic sector in isolation or purely linear formulations.

Many examples of linear models are available. Dennis and Sammet [3], Farris and King [6], Henderson [9], and Snodgrass and French [18] all formulated single-product linear models. Heady and others [2, 5, 8] have developed multiproduct models for U. S. agriculture, with many spatially separated markets and producing regions.

In recent years, attention has turned to quadratic programming models. Takayama and Judge [19] considered both single-product and multiproduct markets in a study that is largely conceptual and illustrative. Plessner and

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Heady [15] considered multiproduct markets for which single-product markets are only a special case. Because of data limitations and limited computer capacities, quadratic programming models rely on the theory and insights of the earlier linear models. Quadratic programming permits the added flexibility of dealing with continuous linear demand functions rather than discrete demanded quantities.

Theoretical Model

In this article we consider a partial equilibrium system for several crop sectors of the agricultural economy. We specify a large number of production regions, partition the continental United States into several spatially separated markets (consumption regions), and define a set of linear demand equations for each consumption region. Using quadratic programming, we determine (a) equilibrium product prices, (b) the associated demanded quantities, (c) the distribution of production among the production regions, (d) the location and quantity of unused cropland, and (e) a set of equilibrium rental prices for land.

Activity analysis as described by Koopmans [10] constitutes the basic theory for our analysis. We assume a linear production economy, thus implying constant returns to scale. Since we are concerned only with the farm sector, we assume that "variable" inputs (inputs produced by other sectors of the economy and farm labor) are available in unlimited quantities at fixed and known prices. Finally, we assume a multiregional economy with several spatially separated markets for the final goods.

Let us suppose that there are K consumption regions, each subdivided into H production regions. Then we define the following symbols:

b^{hk} is an m -vector of available primary resources (land) for production region h in consumption region k ($h=1, \dots, H; k=1, \dots, K$),

x^{hk} is an n -vector of output levels for production region h in consumption region k ,

A^{hk} is a technology matrix relating b^{hk} to a unit of x^{hk} ,

p^k is an n -vector of prices for the elements of d^k ($k=1, \dots, K$),

c^{hk} is an n -vector of costs associated with x^{hk} ,

u^{hk} is an m -vector of imputed values of the primary resources, b^{hk} ,

s^{jk} is an n -vector of shipments from market j to market k ($j \neq k$), and

t^{jk} is an n -vector of costs associated with s^{jk} .

In the application which follows, $m=1$ or 2 and $n=6$. If cropland is the only land constraint, $m=1$; if there are both cropland and soybean land constraints, $m=2$ (see section on production data). There are n final goods and n possible crop-producing activities. Finally, we assume a linear demand system given by

$$(1) \quad d^k = d_o^k + D^k p^k \quad (k = 1, \dots, K)$$

where

d^k is an n -vector of quantities demanded,

d_o^k is an n -vector of constants, and

D^k is a negative semidefinite matrix of constants (required for concavity of equation II.1, below).

Linear case

If the price vector, p^k , is known (that is, if $p^k = \bar{p}^k$), then the demand quantities are also known, that is, $d^k = \bar{d}^k$, where $\bar{d}^k = d_o^k + D^k \bar{p}^k$. With this knowledge, our problem is one of minimizing the cost of producing and transporting a given bill of final goods, \bar{d}^k . Call this Problem I: minimize

$$(I.1) \quad g(x^{hk}, s^{jk}) = \sum_h \sum_k c^{hk} x^{hk} + \sum_{j \neq k} \sum_l t^{jk} s^{jk}$$

subject to¹

$$(I.2) \quad A^{hk} x^{hk} \leq b^{hk} \quad (h = 1, \dots, H; k = 1, \dots, K),$$

$$(I.3) \quad \sum_h x^{hk} + \sum_{j \neq k} (s^{jk} - s^{kj}) \geq \bar{d}^k \quad (k = 1, \dots, K), \text{ and}$$

$$(I.4) \quad x^{hk}, s^{jk} \geq 0.$$

Problem I belongs to the familiar class of linear programming problems. The optimal solution $(\bar{x}^{hk}, \bar{s}^{jk})$ indicates the distribution of production among the K consumption regions that minimizes the cost of producing and transporting, to the region of final consumption, the quantities demanded, \bar{d}^k . This formulation is the basis for many studies of interregional competition [2, 5, 8, 17, 27].

There is, to be sure, no assurance, unless there is explicit provision for foreign imports, that Problem I has a feasible solution for every country in the world. The case for a simplified one-region, two-product situation is illustrated in Figure 1. The demand region, D , and the feasible region defined by the resources, B , have no points in common and thus no feasible solution. For the United States and other such countries, the situation is that illustrated in Figure 2. The area with extreme points A, C, F, E is common to both the demand region and the feasible region defined by the resources. We expect the solution at E .

Nonlinear case

Our problem is more complex if prices, p^k (and consequently d^k), are not known. In most equilibrium analyses, prices and quantities are not part of

¹ If a and b are two vectors, $a \geq b$ implies $a_n \geq b_n$ for all n and $a_n > b_n$ for some n . That is, $a \geq b$ permits strict equality between a and b whereas $a \geq b$ does not. See Koopmans [10, p. 45].

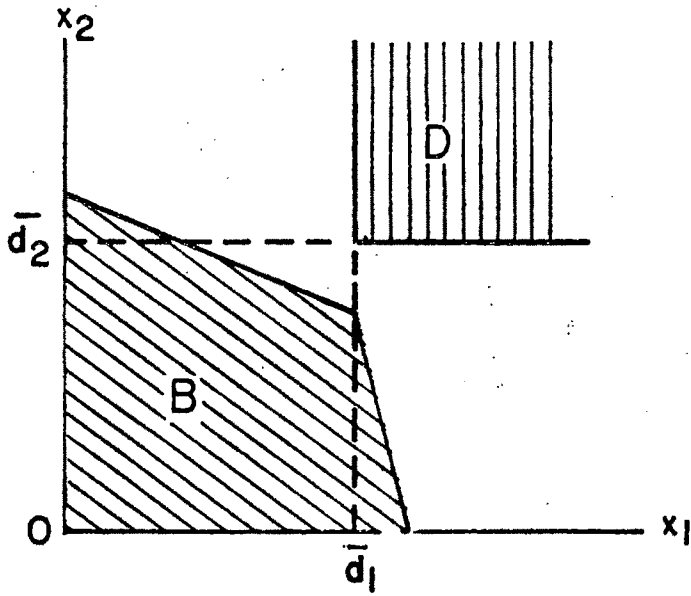


Figure 1. No feasible solution

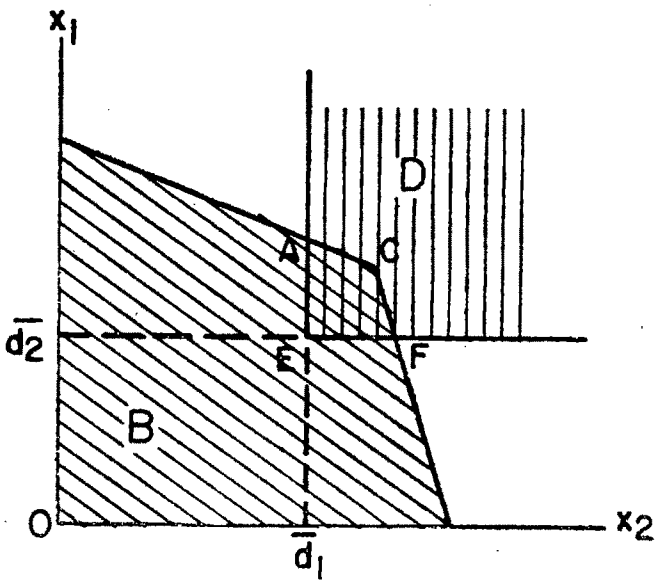


Figure 2. Many feasible solutions

our *a priori* knowledge but are variables whose values we want to determine. When we have estimates for the demand functions, one method of dealing with the difficulty is indicated in Problem II: maximize

$$(II.1) \quad f(x^{hk}, p^k, u^{hk}, s^{jk}) \\ = \sum_{k=1}^K \left[(d_o^k + D^k p^k)' p^k - \sum_{h=1}^H c^{hk} x^{hk} - \sum_{h=1}^H u^{hk} b^{hk} \right] - \sum_{j \neq k} \sum t^{jk} s^{jk}$$

subject to

$$(II.2) \quad A^{hk} x^{hk} \leq b^{hk} \quad (h = 1, \dots, H; k = 1, \dots, K),$$

$$(II.3) \quad p^k - (A^{hk})' u^{hk} \leq c^{hk},$$

$$(II.4) \quad D^k p^k - \sum_{j \neq k} (s^{jk} - s^{kj}) - \sum_{h=1}^H x^{hk} \leq -d_o^k,$$

$$(II.5) \quad p^j - p^k \leq t^{kj},$$

$$(II.6) \quad t^{kj} - p^j \leq t^{jk} = t^{kj}, \quad \text{and}$$

$$(II.7) \quad x^{hk}, u^{hk}, s^{jk}, p^k \geq 0.$$

The quadratic objective function (II.1) consists of total revenue minus production costs, land rents, and transportation costs. Thus, it is a net profit function. Constraint (II.2) requires that land use not exceed availability. Constraint (II.3) requires that marginal returns from an activity be no greater than the marginal cost. Constraint (II.4) requires that production plus net imports be at least as great as demand. This constraint is clearer when written as

$$(II.4a) \quad d_o^k + D^k p^k \leq \sum_{h=1}^H x^{hk} + \sum_{j \neq k} (s^{jk} - s^{kj}).$$

That is, supply must be at least as great as demand for every consumption region $k(k=1, \dots, K)$. Constraints (II.5) and (II.6) are Samuelson's conditions for equilibrium in trade [16].

Not only is the objective function (II.1) the sum of a linear and a quadratic form; it is also concave, since the matrix, D^k , is negative semidefinite. The constraint set (II.2) to (II.7) results from the intersection of a set of half-spaces, implying that it is convex. If the constraint set is not empty, we have all the ingredients for a quadratic programming problem [7, Chap. 7; 26]. Since f is concave, the optimal solution to (II.1), $f(\bar{x}^{hk}, \bar{p}^k, \bar{u}^{hk}, \bar{s}^{jk})$, will be a global maximum.

The optimal solution can be shown to have the following characteristics [13, 14, 15]: (a) $\bar{f}=0$; (b) if all H production regions in the k th consumption region face the prices \bar{p}^k , net profits for each production region are also maximum and zero; (c) for every product with positive output, marginal

cost will equal price; (d) for every product with positive price, supply will equal demand; (e) the trade equilibrium conditions (II.5) and (II.6) will be satisfied as equalities for every product actually traded.

These five characteristics provide a competitive equilibrium solution for the crop sector; but it is a heavily restricted competitive equilibrium since the farm sector is treated in isolation rather than within the entire economy. Because of this isolated treatment, specification of the vector b^{hk} is somewhat arbitrary and probably does not reflect a price-guided allocation of land to the farm sector. Consequently, the volume of output,

$$\sum_{k=1}^K \sum_{h=1}^H \bar{x}^{hk},$$

which results will be very large indeed. Hence, prices and incomes will be very low. The experience with farm programs in recent years confirms this expectation.

Empirical Application

In an empirical application of Problem II, we used the 144 crop-production regions delineated by Heady and Whittlesey [8]. Crops included the major ones used for food and feed: wheat, corn, oats, and barley for food use; all feedgrains; and oilmeals for feed use. This is not an exhaustive list of crops produced in the United States. However, the list does include the main crops in surplus over recent years. Moreover, the farm value of these crops constitutes roughly two-thirds of the farm value of all field crops, excluding commercial vegetables, fruits, and speciality crops such as pecans and walnuts [20, p. 453]. The year 1965 was taken as the base year for the analysis, and all export and population estimates are for that year.

Some allowance had to be made for cotton despite the fact that it was not included in the model. First, we estimated total disappearance (domestic use plus commercial exports) for 1965. Then, we deducted from the total cropland supply enough land to produce the cotton.² This special treatment of cotton was necessary because cotton lint is not a final product, and, thus, there are no demand functions for cotton. Of course, it can be argued that feedgrains and oilmeals are not final products either. The difficulty arises because livestock are not included in the model. As a consequence, feedgrains and oilmeals must be very loosely regarded as proxy variables for livestock products. That is, demands for livestock products are implicit in the demands for feedgrains and oilmeals.

² Even though cotton is not included in the analysis, we could not reasonably ignore the fact that a substantial quantity of land is used in its production.

Demand data

We first derived a set of national, farm-level demand equations for the base year, 1965. This system of equations takes the following form:

$$(2) \quad d = d_o + Dp,$$

where

d is an n -vector of demanded quantities, excluding exports,

d_o is an n -vector of constants,

D is an $n \times n$ negative semidefinite matrix of constants,

p is an n -vector of prices, and

n is the number of final commodities ($n=6$ in this case).

Slope coefficients (elements of D) for wheat, corn, oats, and barley were derived from Brandow's demand slopes [1, Appendix Table 2], with appropriate adjustments for our change in the units of measure. Slope coefficients in our feedgrain and oilmeal equations were derived from Brandow's demand slopes for livestock products (cattle, calves, hogs, sheep and lambs, turkeys, eggs, and milk), using supplemental material from the section entitled "Feed Concentrates, Livestock and Oilseeds" [1, pp. 64-81].

Brandow's quantity estimates [1, Table 9] include demands for domestic food and industrial uses only. We added actual 1965 commercial exports of wheat [23], feedgrains [22], and oilmeals [21], as indicated in the following equations:

$$(3) \quad d_s = d_o + Dp + e$$

or

$$(4) \quad d_e = d_{oe} + Dp,$$

where

$$(5) \quad d_{oe} = d_o + e,$$

d_e is an n -vector of demanded quantities, including exports, and

e is an n -vector of export quantities.

Since available export data do not report separate figures for food uses of corn, oats, and barley, all exports of these three commodities are included in feedgrain exports. The final set of national demand equations, including exports, appears in Table 1.

Next, we partitioned the United States into nine consumption regions (Fig. 3). From the national demand equations (E4), we derived a set of six demand equations for each consumption region. Let d_e^k be the n -vector of

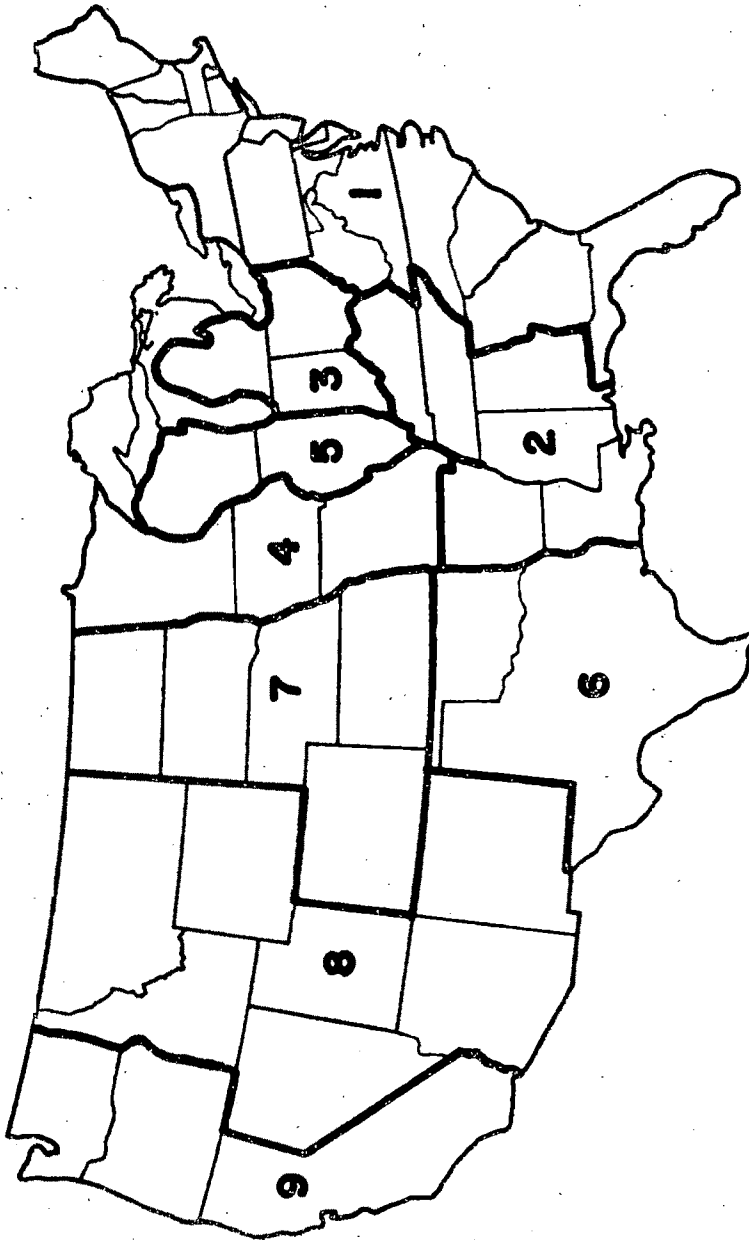


Figure 3. Location of consumption regions in the United States

Table 1. National demand equations, including exports^a

Farm product	Wheat	Corn	Oats	Barley	Feedgrains	Oilmeals	Constant term (d_{0v}) ^b
Wheat	-6.0788	0.4961	0.0462	0.0106	0.0000	0.0000	22,060.1
Corn	0.4967	-4.5229	0.0205	0.0047	0.0000	0.0000	8,105.6
Oats	0.0460	0.0204	-0.4741	0.0000	0.0000	0.0000	706.4
Barley	0.0112	0.0049	0.0000	-0.1201	0.0000	0.0000	145.4
Feedgrains	1.4930	0.6482	0.0556	0.0278	-526.6170	-53.2404	193,600.1
Oilmeals	0.1389	0.0548	0.0185	0.0000	-53.2404	-5.7870	17,211.6

^a Slope coefficients showing effects of a one-unit change in price of the commodity at column head on farm-level demand for commodities at left, and constant (intercept) terms. All prices are dollars per ton and quantity units are thousands of tons.

^b See equation (13) for an explanation of these terms.

demanded quantities, including exports, for region k ($k=1, \dots, 9$):

$$(6) \quad d_o^k = d_o^k + D^k p^k + e^k$$

or

$$(7) \quad d_o^k = d_{oe}^k + D^k p^k,$$

where

$$(8) \quad d_o^k = a_k d_o,$$

$$(9) \quad d_{oe}^k = d_o^k + e^k,$$

$$(10) \quad D^k = a_k D,$$

a_k is the proportion of United States population in region k , and $\sum_{k=1}^K a_k = 1$.

The elements of e^k were derived individually from the elements of e by using Skold's estimates of proportions of farm products exported from each consumption region [17, p. 590]. For example, e_w^k is the quantity of wheat exported from region k ($e_w^k = r_w^k \cdot e$ where r_w^k is the proportion of United States wheat exports shipped from region k). If r_f^k is the proportion of feedgrains exported from region k , then $r_w^k \neq r_f^k$, typically.

Production data

For purposes of defining production activities, we used a partition of the United States into 144 production regions (Fig. 4). This partition has been developed in stages by workers using the model described as Problem I [5, 17, 27]. Homogeneity of input-output coefficients is the criterion for deciding if a given area of land is to be included in a particular production region. In a problem of this size, several compromises are necessary to arrive at a sufficiently small number of regions. Each production region is completely contained in some consumption region, and production in the production region contributes to the supply in the consumption region in which it is located.

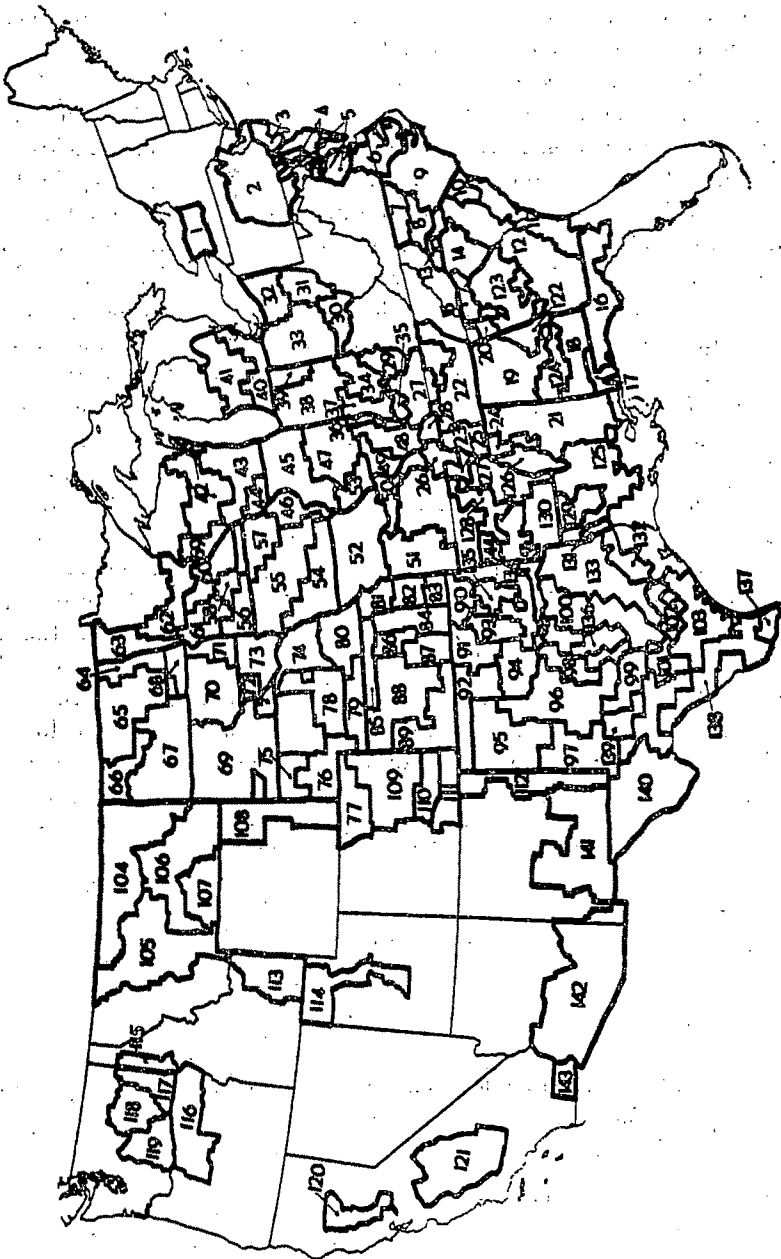


Figure 4. Location of production regions in the United States

We defined a set of seven production activities from which activities for the respective regions could be selected. The seven activities were wheat-for-food, corn-for-food, oats-for-food, barley-for-food, feedgrains, wheat-for-feed, and soybean oilmeal.³ After making allowances for crops not likely to be grown in some regions (for example, soybeans are not produced in Montana), 927 production activities were included in the model. Yields and production costs were adapted from data developed by Whittlesey [27].

Two land constraints, one for cropland and one for soybean land, were developed for each region. Every activity uses cropland. In addition, the soybean activity uses soybean land. Total cropland is essentially an estimate of the acreage devoted to the major field crops (wheat, corn, oats, barley, grain sorghum, soybeans, and cotton), plus diverted feedgrain and wheat acreage, plus conservation-reserve acreage. Cropland (as we use the term here) is total cropland less cotton land.⁴ Soybean land, in those regions where it is defined, is assumed to be 50 percent of total cropland. For the United States, approximate acreages in millions of acres are as follows: 242.1 total cropland, 12.6 cotton land, 229.5 cropland, and 75.1 soybean land. Total cropland estimates were adapted from Mayer [12].

Figure 4 reveals that not all land in the United States is included in the 144 production regions. The excluded area has been named "white area" by previous workers [8, 27] and we will use the same term. Production in the "white area" was estimated by Whittlesey [27] to constitute roughly 5 percent of the United States total for the six crops we are considering. We treat "white area" production as an exogeneous quantity and deduct it from the constant (intercept) term for the consumption region where it occurs. The final demand equation for consumption region k , then, is

$$(11) \quad d_{ew}^k = d_o^k + D^k p^k + e^k - w^k$$

or

$$(12) \quad d_{ew}^k = d_{ow}^k + D^k p^k,$$

where

$$(13) \quad d_{ow}^k = d_o^k + e^k - w^k, \text{ and}$$

d_{ew}^k is an n -vector of demanded quantities adjusted for both exports and "white area" production.

³ To maintain consistency with the definition of x^{hk} as an n -vector ($n=6$), we modify the definition as follows:

$$x^{hk} = [x_{whk} \ x_{chk} \ x_{ohk} \ x_{bhk} \ x_{fhk} + x_{zhk} \ x_{mhk}]$$

where w refers to wheat-for-food, c to corn, o to oats, b to barley, f to feedgrains, z to wheat-for-feed, and m to oilmeals.

⁴ The cotton land referred to here is our estimate of the land required to satisfy domestic and commercial-export demand, not necessarily actual acreage.

Feedgrain activities are composites of the four feedgrains: corn, oats, barley, and grain sorghums. For a given production region, output and costs for the feedgrain activity are weighted averages of outputs and costs of the respective crops. Weights are the proportions of feedgrain acreage represented by the respective crops [17]. In addition to the 927 real production activities or variables, the model also included 249 land constraints (144 cropland and 105 soybean land), 79 transportation activities, and 54 price variables (6 in each of nine regions). The model was formulated as a self-dual problem to assure an objective function value of zero ($\bar{f}=0$) at optimum. With such a formulation, the order of the basic programming matrix was 2672×2672 .

Transportation

Transportation activities permit trading between consumption regions. As noted earlier, production activities contribute to supply in the consumption region where they occur. The transportation activities then permit shipment from regions with excess supply to those with excess demand. With k consumption regions and n products, there are $nk(k-1)$ potential transportation activities, or $6 \cdot 9 \cdot 8 = 432$ in the present case. For practical problems, however, several potential routes are never used. For example, corn is not shipped from Arizona to Iowa. Using such *a priori* information, we reduced the number of transportation activities to 79. Transportation costs were derived by Skold [17] from rail rates listed in the 1962 ICC tariff schedule.

Although our treatment ignores intraregional shipments, such shipments present no conceptual difficulties in models of interregional competition. Intraregional shipments do complicate computational and data problems, however, and we concluded that the potential gain from their inclusion did not justify the extra effort.

Prices and quantities

Using the model described as Problem II, we solved the 144-region problem. Estimated equilibrium prices from the model are substantially lower than 1965 market prices (Table 2). Such a disparity is expected for at least two reasons: (a) the model prices are necessarily short-run since our cost coefficients do not include fixed costs, and (b) market prices were strongly influenced by supply-management and price-support programs. Not all estimated quantities are greater than actual quantities (Table 2). The discrepancies are greatest for food uses of corn and oats, though there is a minor discrepancy for food use of barley. Since 1955-1957 (Brandow's base period), the rates of increase in the use of wet-process corn products and of breakfast food products made from oats have been substantially greater than in the period before 1957 [25, Tables 10 and 11]. Trend terms for Brandow's corn and oats demand equations are simply smaller than the

Table 2. Estimated U.S. demands and prices compared with actual 1965 use and prices

Product	Estimated		Actual	
	Price ^a	Quantity ^b	Price ^c	Quantity ^b
	<i>dollars per bushel</i>	<i>millions of bushels</i>	<i>dollars per bushel</i>	<i>millions of bushels</i>
Wheat, food	0.74	798.74	1.35 ^d	796.50 ^e
Corn, food	0.63	285.86	1.16	332.00 ^f
Oats, food	0.33	43.22	0.62	47.00 ^g
Barley, food	0.57	5.96	1.02	6.00 ^h
	<i>dollars per ton</i>	<i>millions of tons</i>	<i>dollars per ton</i>	<i>millions of tons</i>
Feedgrains	22.49	172.27	40.51 ⁱ	148.77
Soybean oilmeal	43.98	21.42	65.41 ^j	13.45

^a Weighted average of regional prices in Table 3, with regional production as weights.

^b Includes commercial exports.

^c Seasonal average price received by farmers. Source: USDA [21; 22, Aug. 1967; 23, Aug. 1967].

^d Participants in the government wheat program received an average additional \$0.44 in the form of wheat certificate payment. Source: USDA [23, Aug. 1967].

^e Includes food and industrial uses. Source: USDA [23, Aug. 1967].

^f Includes breakfast foods, cornmeal and grits, and wet-process products. Source: USDA [25].

^g Includes domestic use for food. Source: USDA [25].

^h Includes barley-equivalent use of malt food. Does not include uses of malt for alcohol and alcoholic beverages (98.35 million bu.). Source: USDA [25].

ⁱ Weighted average of the prices of corn, oats, barley, grain sorghum, and wheat. Weights were the quantities fed plus commercial export of the first four grains and quantity of wheat fed.

^j Assumes (1) that there are 0.0233 tons of meal per bushel of soybeans, (2) that meal constitutes 60 percent of the value of soybeans, and (3) that the price of soybeans is \$2.54 per bushel. Source: USDA [24].

actual rates of increase between 1957 and 1965. Quantity differences for wheat, feedgrains, and soybean oilmeal are in the direction expected; that is, estimated quantities are greater than actual quantities. These results suggest the need for tying the demand data to a more recent base period in future applications of this kind.

Estimated prices received by farmers in each consumption region are listed in Table 3. The range in prices for some commodities is as follows: wheat, \$0.48 in region 8 to \$1.20 in region 1; feedgrains, \$16.12 in region 8 to \$38.34 in region 1; oilmeals, \$38.82 in region 7 to \$61.22 in region 1. The pattern that emerges is one for which prices, in general, are highest on the East and West coasts and lowest in the Corn Belt and northern Great Plains. Such a pattern reflects the fact that excess production occurs in the Corn Belt and northern Great Plains and excess demand on the two coasts.

Land use

After land was deducted for cotton production, approximately 229.5 million acres were available for crop production (not including "white

Table 3. Estimated farm prices by consumption region

Consumption region	Wheat ^a	Corn ^a	Oats ^a	Barley ^a	Feedgrains	Soybean oilmeal
	<i>.....dollars per bushel.....</i>				<i>.....dollars per ton.....</i>	
1	1.20	0.85	0.65	0.74	38.34	61.22
2	1.17	0.84	0.57	0.82	33.34	51.32
3	1.12	0.59	0.50	0.73	26.34	50.52
4	0.58	0.45	0.34	0.48	19.34	42.72
5	0.86	0.53	0.44	0.54	22.54	47.33
6	0.57	0.61	0.26	0.44	18.90	50.29
7	0.50	0.38	0.28	0.37	16.83	38.82
8	0.48	0.87	0.37	0.42	16.12	61.12
9	1.02	0.86	0.55	0.78	33.93	61.12
U.S.	0.74	0.63	0.33	0.57	22.49	43.98

^a Prices for food use.

area" land). Under the specified equilibrium and model conditions, roughly 179.3 million acres of this were used and 50.2 million acres remained idle. When 9.9 million acres of "white area" production were added, there was an estimated total of 189.2 million acres of crops. In contrast, 179.99 million acres of the six crops were actually harvested in 1965 [21, 22, 23]. Table 4 shows the acreages, both estimated and actual, and Figure 5 shows the distribution of the estimated idle cropland among the various production regions. Idle cropland is concentrated in Alabama, Louisiana, Mississippi, New Mexico, North Dakota, Montana, Wyoming, Idaho, and Utah.

Interregional commodity shipments

Figures 6, 7, and 8 show the areas of excess production and excess demand for food wheat, feedgrains (including feed wheat and food uses of corn, oats, and barley) and oilmeals, respectively. As mentioned before, excess

Table 4. Estimated and 1965 actual U.S. crop acreages

Crop	Estimated acreage ^a	Harvested acreage 1965
	<i>.....millions of acres.....</i>	
Wheat	54.42 ^b	49.56
Feedgrains	101.96 ^c	95.98
Soybeans	32.83	34.45
Total	189.21	179.99

^a Includes the following "white area" acreages: wheat 2.29, feedgrains 7.47, soybeans 0.10.

^b Includes acreages for both food and feed uses.

^c Includes acreages for food use of corn, oats, and barley.

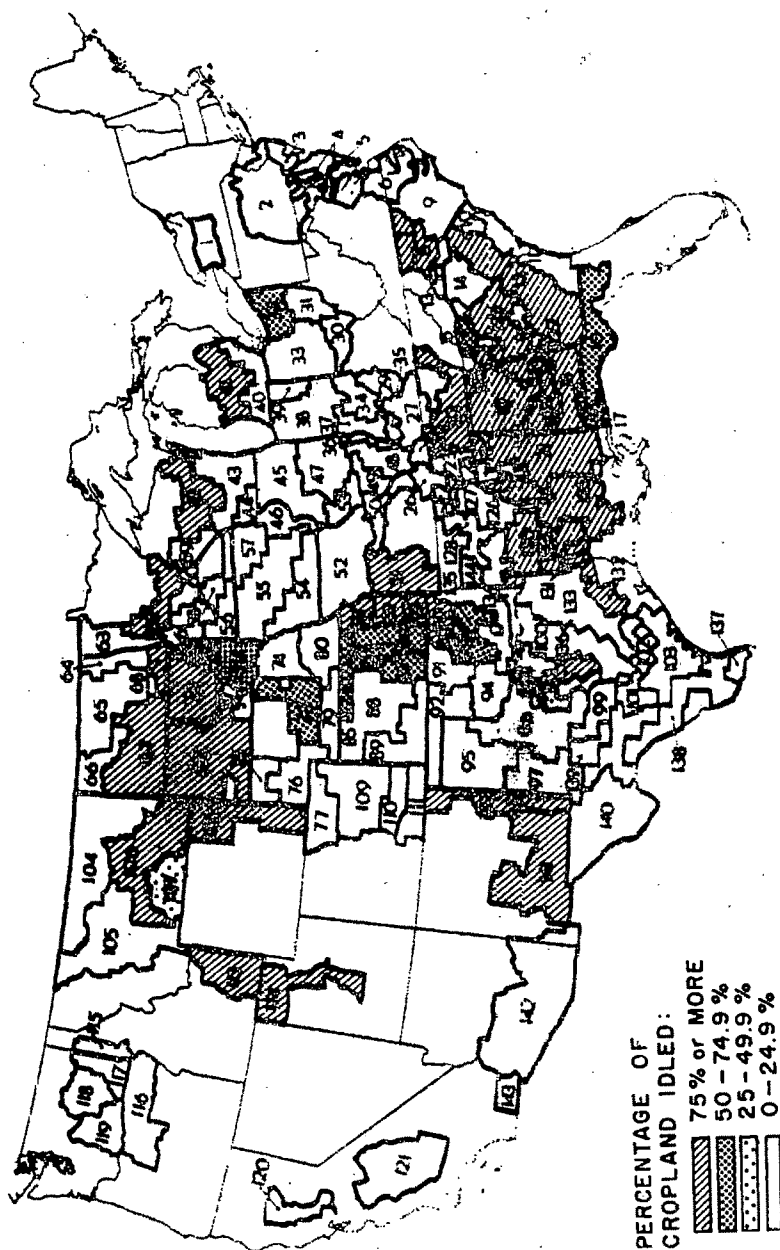


Figure 5. Distribution of idle cropland among U.S. production regions

production generally occurs in the Corn Belt and Great Plains and excess demand in the coastal areas. In addition to the greater population in the coastal areas, regional demands in these areas include allowances for most of the foreign shipments. The estimated pattern is very much like the actual pattern.

Since the model requires that $p^j - p^k \leq t^{kj}$, the strict equality will hold for any two regions for which $s^{jk} \neq 0$. There is no incentive to trade unless the price differential at least covers transport cost. Equilibrium does not exist, under the assumptions of the model, if the price differential is greater than transport cost.

Conclusions and Prospects for Further Research

In the applications of his model [1, pp. 81-105], Brandow determined the market-clearing prices for various given supply levels. Linear models of interregional competition take demand as given and determine the least-cost production pattern for satisfying the demand. In our Problem II, we combine the two approaches and determine demand and supply simultaneously. The results support the contention of some that, under a "free" market situation, supply would be greater and prices substantially lower than at present. We have not as yet made any policy applications of the model, but we hope, in a subsequent article, to demonstrate some of the ways in which the model can be used to evaluate alternative policies.

Our purpose in this study was not to estimate demand functions. It is evident, however, that studies based on models such as this one will require refined estimates. Previous estimates of the food demand structure have usually concentrated on the reasonableness of average price and income elasticities. Now, we are equally interested in the behavior of elasticity estimates over wide ranges of the functions and in the reasonableness of the intercept values. Improved cost and technical data are always needed, and we are working on this aspect.

This equilibrium study is only the first phase of a larger study based on quadratic models of United States agriculture. In a phase now under way, we incorporate livestock directly, rather than indirectly as here. Future adaptations will be made to incorporate fixed costs and new estimates of demand functions. Our aim is toward the rather long period required to make models of this type completely operational for evaluating policy phenomena and choices. We hope, as work progresses, to incorporate improvements in both the data and the model.

Despite the many necessary qualifications, we believe that the results reported here represent a substantial beginning toward generating quantitative knowledge of both policy and scientific interest.

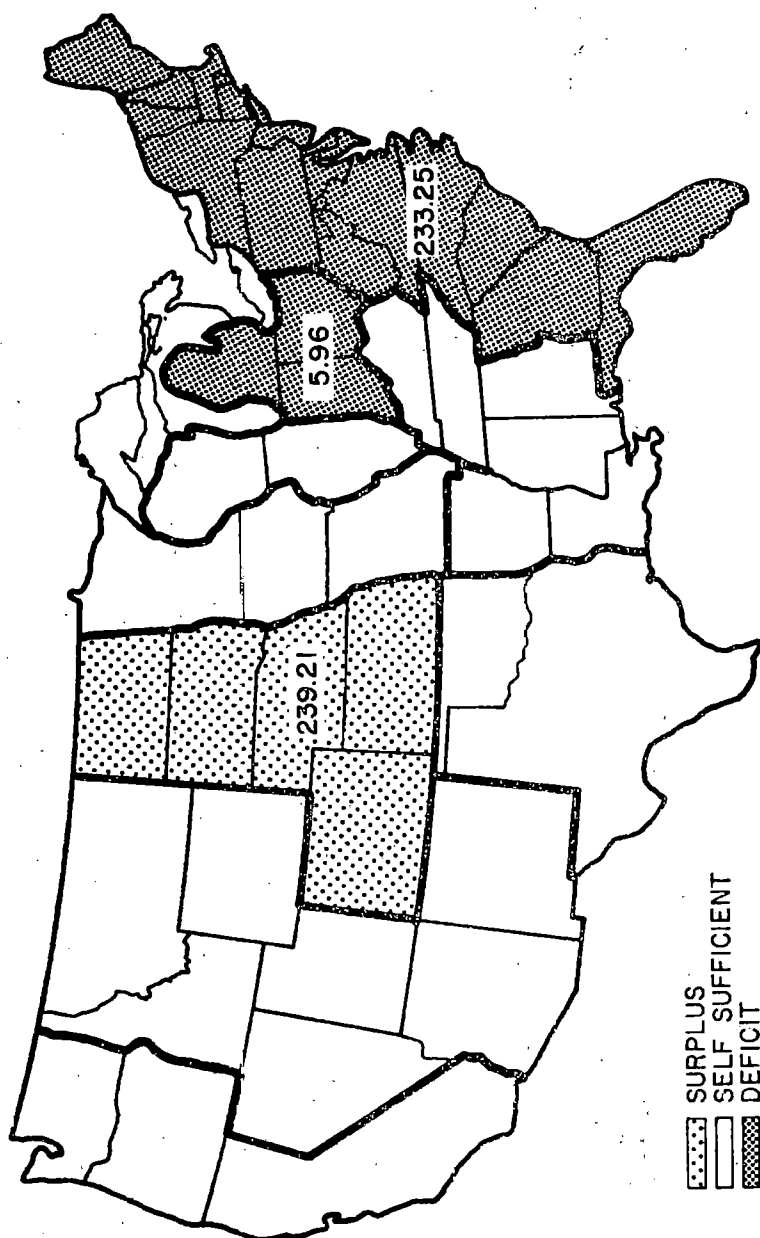


Figure 6. Interregional flows of food wheat in millions of bushels

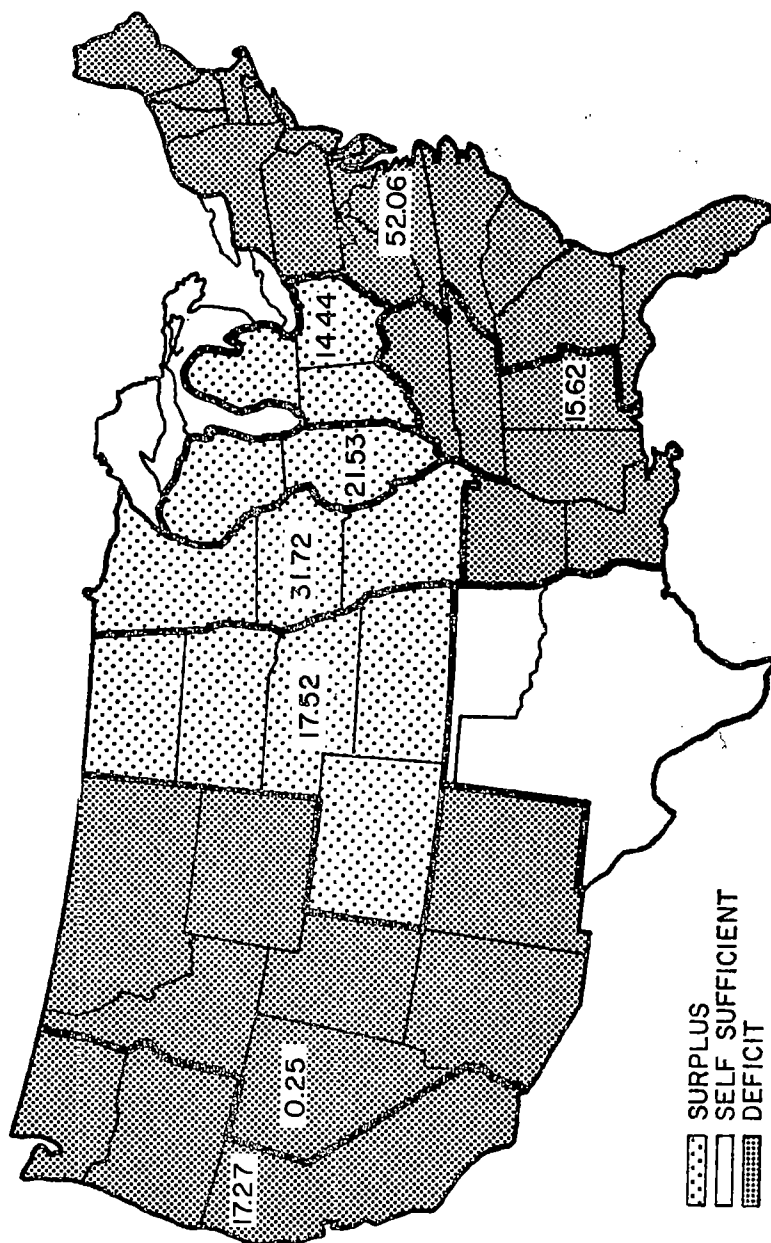


Figure 7. Interregional flows of feedgrains (including feed wheat and food uses of corn, oats, and barley) in millions of tons

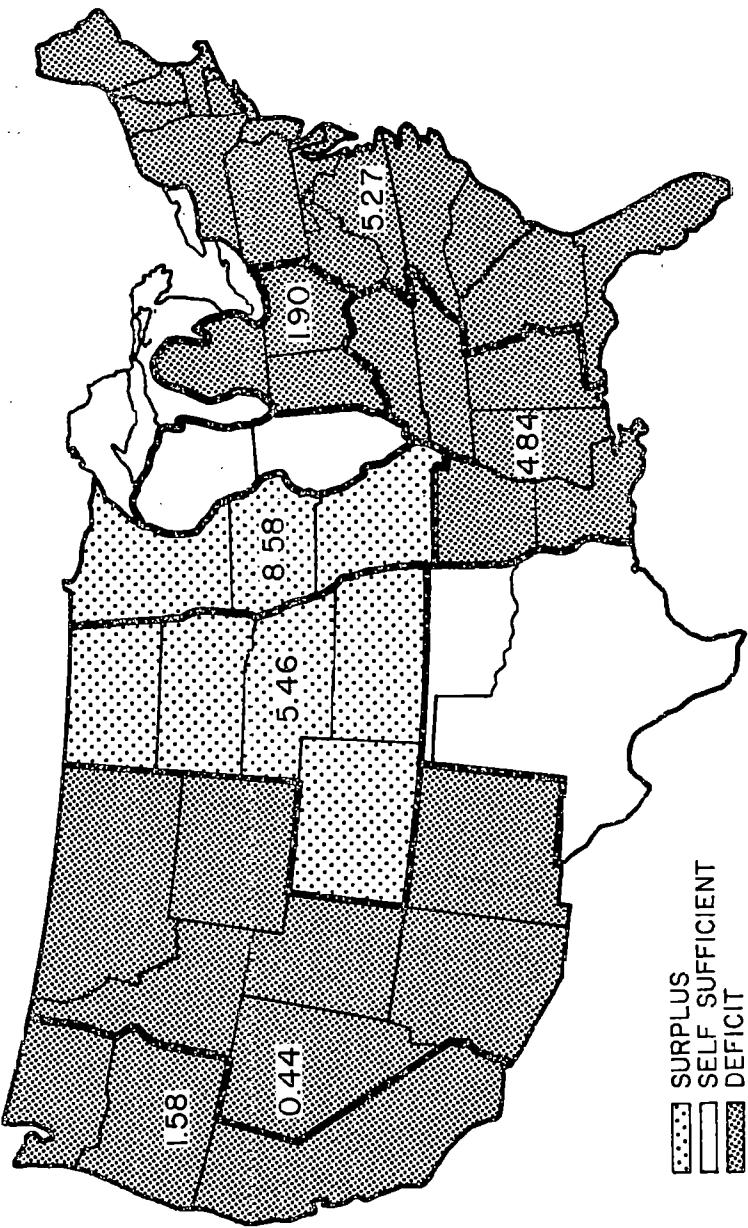


Figure 8. Interregional flows of soybean oilmeal in millions of tons

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Transfer Restrictions and Misallocations of Irrigation Water*

B. DELWORTH GARDNER AND HERBERT H. FULLERTON

The hypothesis of the study is that allowing intercompany transfers of irrigation water would significantly increase the marginal value product of water. Regression analysis was used to explain a time series of rental prices for an area in Utah where four companies freely exchanged water after a long period during which only intracompany transfers were permitted. Water delivered per irrigated acre and type of transfer policy in use were the statistically significant variables and explained 89 percent of the variance in rental price. Covariance analysis indicated that the greater flexibility in transfer increased the real price of water per acre-foot by \$1.84.

A **SIZABLE** literature relating to water transfer has appeared during the last decade. Many publications have been concerned with the "criteria" issue of whether transfers are justifiable or not [3, 5, 6, 7, 10, 17]. Some have attempted to establish water values, in the aggregate and at the margin, which are prerequisite to optimal resource allocation [1, 11, 14, 15, 18].

It is apparent that legal and institutional rules and policies tend to restrict water utilization to certain kinds of uses and classes of users. It has been argued in principle that these transfer impediments are inefficient [2, 4, 13]. But the degree of inefficiency is difficult to pinpoint empirically because actual conditions for unrestricted movement of water seldom exist and thus a norm of "maximum" efficiency is hard to acquire for purposes of comparison. One case from Utah sheds considerable light on the magnitude of the misallocation that may be involved. This article reports the gains in value productivity of water that followed relaxation of a policy forbidding anything but intracompany transfers in an area where several mutual irrigation companies operate.

Criteria for Economic Efficiency

In principle, maximum productive efficiency can be said to exist when the factors of production are used in optimal proportions with optimal technology and are applied to those uses where total value product is maximized. The economic welfare of the owners of the factors of production is a function of the productive efficiency of the factors, and, in turn, the economic welfare of the community is a function of the welfare of the factor owners.

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Theoretically, provided that there are no externalities, each factor will be optimally allocated (used) when the values of marginal product of that factor in various uses and among competing users are equal. In a perfectly competitive market in equilibrium, factor prices will be equal to the values of marginal product for all factors. One of the conditions for perfect competition is that factors are free to seek employment where they can bring maximum returns to their owners. If factors are immobile because of transfer restrictions, it is probable that the values of marginal products will be below optimal levels in current uses and that observable market prices will reflect the lower productivity.

If factor prices are generated under both restricted and unrestricted transfer, then any discrepancy in prices may be taken as a measure of the inefficiency caused by the transfer impediment, provided that all other variables affecting price are the same in the two market situations.

Our approach is to observe water prices under two transfer arrangements. We assert that these prices reflect the values of the marginal product of water, given the water supply. Increases in the price of water under a different transfer arrangement may result from two factors: (1) an increase in the actual marginal value product of water toward its potential maximum value, provided that there are no shifts in other variables which may also contribute to the price rise, and (2) a reallocation of the water supply from companies of high supply and low water value to companies of low supply and high value. The first point involves a shift in the marginal productivity curve and the second point a movement along the curve to a greater level of marginal productivity. A change in price is observable, but there is no easy way of determining whether it results from a shift in the productivity curve or a movement along it. For simplicity, we assume that an increase in price is represented analytically by a shift in the curve.

Let D_0 in Figure 1 be the value-of-marginal-product schedule for water under an initial set of transfer rules. S is the supply per acre. The price (observed value of marginal product) is P_0 . Let D_1 represent the schedule after a shift in transfer policy. P_1 is the observed water price. P_0P_1 is the gain in value of marginal product due to the shift in transfer arrangements. The annual gain in total value productivity is $(P_0P_1)S$.

How might a shift in transfer rules change the value-of-marginal-product schedule for water? There are several possibilities that might be advanced: (1) If the rule change effectively reduces production risk, then the production function should shift upward. (2) Even though the average quantity of water used remains constant, if the rule shift permits better timing of water application during the season and more optimal allocation between years, then the production function will shift upwards. (3) If the rule change increases water mobility to permit a more efficient cropping pattern or a shift of more profitable crops to the better lands or farmers, then the area

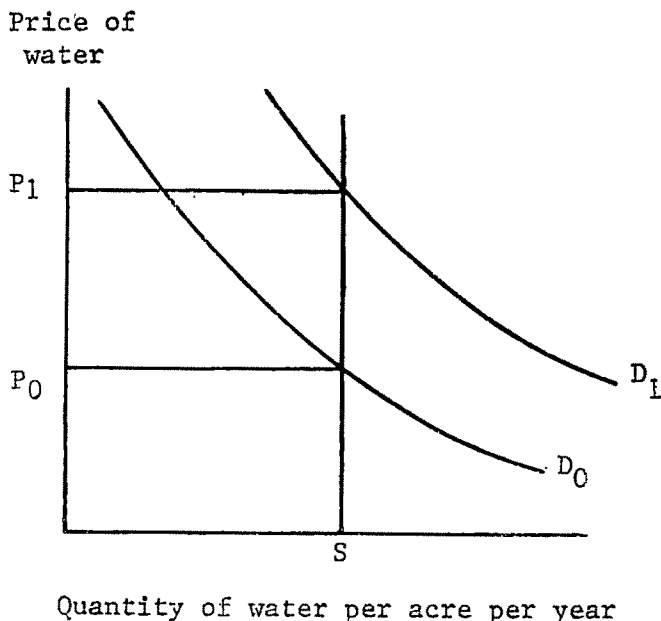


Figure 1. Illustrative demand curves for water under differing transfer arrangements

production function should shift upward. More will be said later about the applicability of these possibilities to the area being studied.

The Rental Market, Water Prices, and Variables Affecting Water Price

At the end of the Sevier River in Utah is an irrigated area of about 40,000 acres which is used mostly for the production of alfalfa, although sugar beets and potatoes are also grown.

Four mutual irrigation companies service the area with water. Since there are no irrigators or other water users on the river below, third-party effects outside the area are negligible. Since such externalities are nonexistent, an objective function which maximizes net benefits for the area being studied also maximizes net social benefits in total. The simplicity of the situation being studied has two important implications: (1) Were it not for the small size and relative simplicity of the agricultural economy being studied and the absence of externalities, it would be much more difficult to identify and quantify the misallocation due to transfer impediments. (2) Great care must be exercised in applying the results of the study without qualification to more complex situations, such as large interbasin transfers, where the objective function would be much more complex.

Before 1948, only intracompany transfers of water were permitted. In 1948, by mutual consent of all four companies, it became possible to transfer water between companies as well as within each company.

A description of the water market

Recorded rentals have occurred within some of the companies for more than 30 years, and hundreds of transfers are made each year. In one year, about 30 percent of the total water supply was transferred. Water trades were common practice long before any formal records were kept. Price observations were available both before and after the 1948 change in transfer policy. Because of the large numbers of transfers, buyers and sellers numbering in the hundreds, the close physical proximity of buyers and sellers, and the ease with which transactions can be made, a competitive pricing model is applicable.

Rental values were compared for periods before and after intercompany transfer restrictions were lifted. Because the data under comparison were generated in different time periods, it is possible that factors other than the change in transfer policy might have influenced rental prices. For example, the marginal product of water might have been influenced by changes in water availability, prices of farm products, quantities of other inputs, or shifts in technology.

Multiple regression analysis was utilized to determine which of the variables with *a priori* importance had significant influence on the rental price of water. Covariance analysis was used to determine the impact of a change in transfer rules on water rentals after the effect by other significant variables had been removed.

Water rental values (Y)

The dependent variable was the value of annual water rentals. Since 1950 there have been no differences among companies in price, because a common market has existed for all. However, reliable price data are available for only one of the four companies for the years before 1950. (Records for the other three simply do not exist, although it is clear that there were separate water markets in each of them.) Annual prices reported for this one company were therefore assumed to reflect the average price for all companies in the period before intercompany transfers. This assumption requires further explanation and rationalization. Obviously P_0 and P_1 in Figure 1 must be accurately measured if their comparison is to have meaning.

During the years when intercompany transfers were not permitted, individual company prices must have been different if there were to be efficiency gains by later intercompany transfers. In view of the fact that some companies depended entirely on surface flow whereas others had storage facilities, price differences must have existed. In dry years, the intracom-

pany rentals for the companies dependent on surface flow could have been expected to be higher, *ceteris paribus*, than those of the storage companies; in wet years, the reverse would have been true.

In Figure 2, suppose that D represents a value-of-marginal-product schedule common to all four companies. The company for which data are available for the years before the rule change is company A. Suppose that the water supply to company A was S_a , yielding a value of marginal product of P_a . Suppose that the supply to the other companies was S_b and that the value of marginal product was P_b . It is apparent that P_a would understate the area-average marginal productivity of water and that if P_a were compared to a higher common price (say P_c) after intercompany transfers were permitted, the difference $(P_c - P_a)$ would exaggerate the "true" gains in productivity. The opposite would be true if P_c were greater than P_b . The difference between P_a and P_c would then understate the efficiency gains which are due to increased mobility. Therefore, it was necessary to devise some test that would reveal the bias of P_a as a reflection of area-average marginal productivity. The results of this test depend on whether A was on balance an importer or an exporter of water.

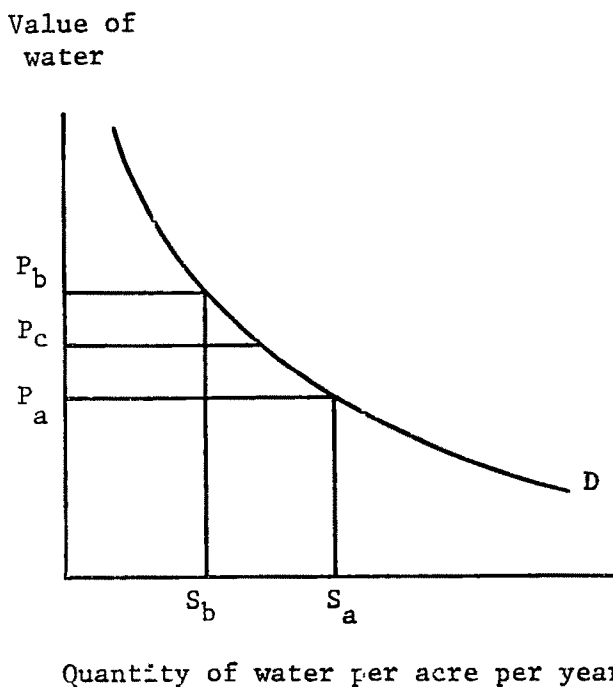


Figure 2. Demand for water and assumed prices for various irrigation companies

Suppose that P_a is smaller than P_b . Relaxation of the transfer impediment would mean that water would be transferred from company A to the other companies, where returns would be higher. Company A would be an exporter of water. This is the worrisome situation, because productivity gains in transfer would thus be overstated if P_a were used as the area-average price. On the other hand, if P_a were greater than P_b , then transfer freedom would result in water movement from the others to company A, which would then be an importer. In this case, at least, the productivity gains would be understated, and any claims of greater efficiency would be conservative.

Transfer data from the area reveal that in only 4 years between 1951 and 1963 was company A an exporter of water and that in 2 of the 4 years the amount exported was insignificant. No transfer data were available for 1953 and 1954. On the other hand, in 7 of the 11 years, company A was a strong importer. Thus, it would appear that P_a on the average was greater than P_b , and therefore the use of P_a to represent the value of marginal product of water for all four companies will, in fact, understate the efficiency gains of transfer flexibility.

In addition, company A is the largest and oldest of the four companies. The intracompany market of A was better developed before 1948 than the markets of the other companies. Thus, for all the above reasons, P_a should have been greater than P_b and any efficiency gains reported here should be conservative.

Column 2 in Table 1 contains the deflated series of rental prices reflecting the value of marginal product associated with the years before and after the change to an intercompany transfer policy in 1948.

The length of the series was limited by a number of factors. Among these were the availability of reliable data, government activity in the water market, and the depressed economic conditions before 1934. Although price data were available for years before 1934, forced sales of water stock and generally chaotic financial adjustments in the area and in the irrigation companies themselves suggest that rental prices may not have been reliable indicators of value of marginal product before 1934.

The period 1934–1941 was relatively stable in the water market. The debts of the irrigation companies and drainage districts in the area had been readjusted and placed on a sound basis by refinancing. The amount of irrigated land remained virtually constant, and general economic conditions were reasonably stable.

In 1942, the government began purchasing water stock at a price considerably above the irrigation market price in order to obtain water for a Japanese-American relocation project that was to be constructed in the area. This action had the effect of tightening the rental market to such an extent that few rentals occurred, and virtually no rental-price data were

Table 1. Water rentals, transfer arrangements, water availability, and expected product prices under two allocative policies, 1934-1964

Year	Rental price ¹ per acre-foot ^a Y	Transfer arrangement X_1	Water available per irrigated acre X_2	Expected alfalfa seed price per 100 lbs. clean seed ^a X_3	Expected livestock price per 100 lbs. live weight ^a X_4
	<i>dollars</i>		<i>acre-feet</i>	<i>dollars</i>	<i>dollars</i>
1934	3.49	0	1.2986	25.43	12.01
1935	5.71	0	0.7420	35.62	10.87
1936	4.12	0	1.0203	31.78	12.39
1937	2.52	0	1.5478	37.05	13.11
1938	2.02	0	2.1333	46.16	13.95
1939	2.37	0	1.8551	43.88	14.15
1940	2.91	0	1.8551	42.66	15.43
1941	2.55	0	2.1333	37.94	16.53
1950	3.55	1	1.8168	40.93	24.12
1951	5.66	1	1.3938	48.96	26.19
1952	3.95	1	2.2417	50.07	29.15
1953	2.70	1	2.2250	40.01	28.54
1954	6.46	1	1.3772	31.43	23.29
1955	6.44	1	1.3951	36.47	20.38
1956	10.40	1	0.9441	27.65	18.45
1957	15.15	1	0.9715	29.76	16.72
1958	4.98	1	1.8475	28.23	17.17
1959	6.96	1	1.4131	25.00	20.22
1960	15.89	1	1.0327	25.80	21.87
1961	19.94	1	0.8249	24.94	21.01
1962	9.94	1	1.4644	30.99	20.65
1963	16.95	1	0.8809	28.09	20.06
1964	15.00	1	1.0454	32.00	20.46

^a Prices received in Utah as reported by Statistical Reporting Service, adjusted to real terms by using the U.S. Wholesale Price Index as a deflator.

available for the years 1942-1947. In addition, there was the typical war-time distortion of prices and market conditions. Both factors prompted the exclusion of this period from the earlier series. Thus, rental prices recorded between 1934 and 1941 were used as a measure of the values of marginal product for water under the allocative policy which limited transfers to the extent of each company's canal system. By 1950, the intercompany transfer policy was well established, and excellent price data were available. Consequently, all the rental prices between 1950 and 1964 were included.

Since these two sets of prices spanned two decades in which there were sharp changes in the aggregate price level, annual prices were deflated by the wholesale price index for all commodities, a process which made them comparable in purchasing power to other commodities.¹

¹ Since alfalfa seed and livestock prices, as well as water prices, were also deflated, the same index should be used on all three series. Their movement relative to each other is essential for

Explanatory variables

Transfer policy (X_1).—The type of transfer policy in effect is shown in column 3 of Table 1 as a dummy variable. The policy of intracompany transfers from 1934 to 1941 is represented by the value 0 and the intercompany transfer policy of 1950 to 1964 is represented by 1.² The primary hypothesis of the study is that when intercompany transfers are permitted, the value of water as represented by rental prices should rise significantly. That is, the regression coefficient $\hat{\beta}_1$ should have a positive sign, and the size of the coefficient (in nonlogged units) should represent the increase in the real price of water due to the rule change.

In Figure 3, as in Figure 1, D_0 is the value of the marginal product schedule before the rule change and D_1 is the schedule after. In the regression equation containing the dummy variable X_1 , the constant term α is the intercept of D_0 . The intercept of D_1 , on the other hand, will be $\alpha + \hat{\beta}_1$, making

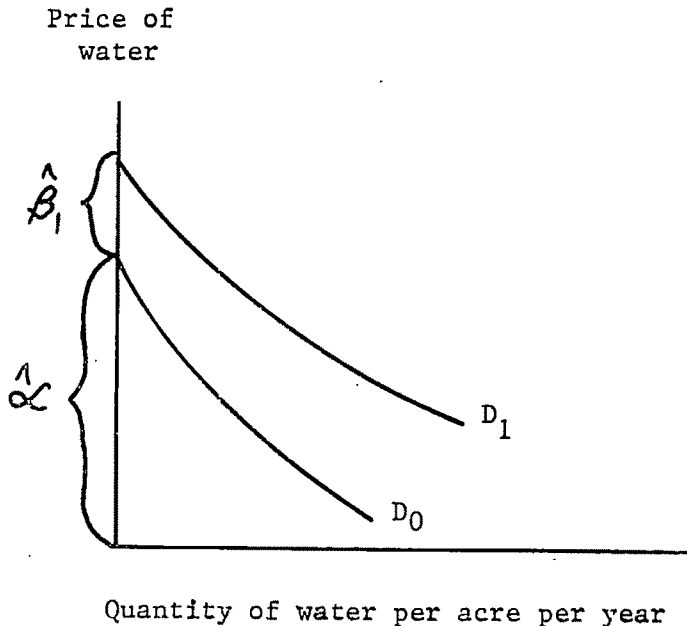


Figure 3. The value of water under restrictive and nonrestrictive transfer conditions

the regression analysis reported in this article. What seemed to be most relevant was the purchasing power of the various series, not their value relative to such factors as farmer inputs and land prices. Thus, the wholesale price index (1957-1959 = 100) seemed a good choice.

² For a discussion of dummy variables and the terminology and interpretation of Figure 3 used in this paper, see Johnson [9, pp. 221-228].

$\hat{\beta}_1$ the difference in real price due to the rule change. Covariance analysis will be used to determine whether the slopes of D_0 and D_1 are significantly different, which in effect is a test to determine whether $\hat{\beta}_1$ is constant regardless of the quantity of water used.

Water availability (X_2).—*A priori*, the rental price of water should be affected by the quantity of water available for use. *Ceteris paribus*, a reduction in the supply of water should cause the market price to increase and $\hat{\beta}_2$ would have a negative sign.

Because the price data for the early period were representative of just one company and those for the later period of all four companies, water deliveries were divided by the number of irrigated acres, yielding water delivered per irrigated acre. This variable appears in column 4 of Table 1. The mean difference of quantities of water available in the two periods was not statistically significant.

Expected product prices (X_3 and X_4).—Expected product prices were deemed more appropriate than observed prices in a given year. The farmer makes all management decisions on the basis of what he expects the price to be when he markets his products. Most commodity prices are somewhat volatile. What a farmer expects in the future is usually some function of what he has observed in the past. Under these circumstances, it seems reasonable to assume that price expectations will be a function of a considerable number of past observations of the same variable. Where there are trends or cycles in prices, an expectations model which gives highest weights to the most recent observations will generate more realistic price expectations. A widely used model of this type [12] was employed in calculating expected prices in this analysis. It utilizes past prices and attaches decreasing weights to successive price observations as they recede into the past.³ The particular function used is as follows:

$$P_e = \epsilon P_t + (1 - \epsilon)\epsilon P_{t-1} + (1 - \epsilon)^2\epsilon P_{t-2} + \cdots + (1 - \epsilon)^{n-1}\epsilon P_{t-(n-1)}$$

where

P_e is the expected value of P ,

$P_t, P_{t-1}, \dots, P_{t-(n-1)}$ are the observed values of P for n time periods beginning with $P_{t-(n-1)}$ and extending forward to the current period t , and

$(1 - \epsilon), (1 - \epsilon)^2, \dots, (1 - \epsilon)^{n-1}$ are the weights to be applied to the P 's observed in the periods t back to $t - (n - 1)$.

We assumed that ϵ was 0.5 for our study. A coefficient of this size gives the most recently observed price a weight just equal to the proportion of the total weight assigned to all other observations. Under this assumption,

³ Of course, other models for computing expected prices could have been used, such as the "outlook" prices formulated by the USDA for future years. The expectations model used in this study has the advantage of generating expected prices from actual past prices.

99.9 percent of the total weight attached to the expected price is accounted for in the last ten years.⁴

Alfalfa seed and livestock products are the major sources of income for the area.

In the agricultural census years 1939, 1944, 1949, 1954, and 1959, alfalfa seed accounted for an average of 61 percent of the value of all field crops sold in the county encompassing the study area. Most of the alfalfa seed produced in the county was grown in the study area. Irrigation company officials estimate that 80 to 90 percent of the irrigated acreage in the area is planted to alfalfa. The general practice, in seasons of good water supply, is to cut a first crop of hay for livestock feed and produce the second crop for seed. In years of short water supply, the first crop is saved for seed.

Alfalfa seed prices were not available from the study area. Because alfalfa seed produced in the study area, however, represents about 60 percent of Utah's total production, prices for Utah seemed appropriate for the study area. The supply produced by Utah is only a small part of the national supply. What happens in the study area to alfalfa seed production, therefore, has little impact on the national price.

In the census years since 1939, sales of livestock and livestock products have accounted for an average of 59 percent of the value of all farm products sold in the county. There is no satisfactory way of weighting all livestock classes to derive a composite price for all livestock products. Sale of cattle and calves accounted for over 50 percent of the value of livestock and livestock products sold. Therefore, the weighted average of cattle and calf prices in Utah served as a proxy variable representing livestock product prices.

Livestock is an indirect product of irrigation water. If the expected price of livestock were relatively high, more water should be demanded for the production of hay. Hay requires more water than alfalfa seed. Expected livestock price thus may have an indirect but positive effect on the rental price of water. The estimated regression coefficients of both expected alfalfa seed prices (X_3) and expected livestock prices (X_4) should have positive signs.

Refinements of both alfalfa-seed and livestock price data included deflation by the wholesale price index and the calculation of an expected price for each year. Expected prices for alfalfa seed and livestock are listed in columns 5 and 6 in Table 1.

Quantities of other inputs.—The quantities of other inputs used in con-

⁴ Other studies of agriculture have calculated ϵ from the price data in such a way as to yield regression results with maximum fit. Nerlove [12] has estimated ϵ to be 0.5 for wheat, corn, and cotton. It seems plausible that alfalfa seed and livestock prices would have variances over the course of time similar to those of wheat, corn, and cotton prices, and thus coefficients of expectation would not be very different.

junction with water could also be expected to affect the rental price of water. If quantities of other factors used jointly with water were increased, the marginal physical product of water could be expected to rise. Foremost in importance among these other inputs is land.

Between 1934 and 1964, the irrigated acreage in the area was relatively constant. Therefore, variation in irrigated acreage could not materially affect the productivity of water and thus the rental price. No other input class, except possibly capital, seems to have increased significantly over the period of the study. Capital and technology are discussed below. Labor inputs declined in the area, following the national trend. This should have decreased the marginal productivity of other important factor groups; how much is unknown. The *a priori* direction of the impact is opposite to the observed increase in water price; hence, it is highly unlikely that the increase in water prices could be accounted for by labor inputs.

Technology and capital.—New technology could be expected to affect the productivity of water. The introduction of a technological advance, such as hybrid seed, or a more efficient machine, may generate a new production function such that greater output is obtained with the same expenditure of resources. This may have the effect of increasing the “rents” of factors with inelastic supplies and the prices of these factors may be bid up.

Since 1940 there have been numerous technological advances in United States agriculture. Among these are commercial fertilizers, insecticides, mechanization, and new crop varieties. For the most part, technological development is output-increasing and is reflected in increased crop yields per acre. Increasing yields, therefore, are often an indicator of technological advance. Since alfalfa seed is such an important crop in the study area, any significant technological advance might be expected to increase alfalfa seed yields. There is no evidence that this has occurred. No data were available on yields from the study area itself, but since the area produces 60 percent of Utah's supply, the state yields should be reasonably representative of area yields. The average yield of clean alfalfa seed per acre in the state of Utah was 155.38 pounds for the 21 years before 1940, and 153.53 pounds for the 25 years after 1940.

Although several new varieties of alfalfa have been developed, there is no evidence that any variety was introduced because of its higher seed yields or lower input costs.

Soil studies conducted in 1919 [16] indicated that no commercial fertilizer and very little manure were used in the area. A later study [8] indicates that the soils of the area contain ample quantities of all elements except nitrogen. The first census report of fertilizer use in the county encompassing the area was in 1954, when 1,331 tons were used on only 9,077 acres in the entire county. By 1959, this had decreased to 888 tons used on 5,193 acres. If it is assumed that all fertilizer was used on irrigated lands, only 11.1 percent of

the irrigated land in the county received fertilizer in 1954 and 6.8 percent in 1959. Thus it would appear that fertilizer application is independent of water supply and that the quantity used has decreased between two years when other inputs remained nearly constant. In addition, since 80 to 90 percent of the land is planted to alfalfa, a nitrogen-producing crop, fertilizer simply is not needed. Thus, there is no evidence that fertilizer application has had any effect on the value of the marginal product of water and therefore on rental prices.

Although some new mechanical tools have been introduced in the area, there is nothing to indicate that they have affected yields. It is a general trend in agriculture that mechanization replaces labor. There is no evidence that capital and labor combined (the total inputs committed except for land and water) have increased on a per-acre basis, a condition which would be necessary to induce an increase in the marginal product of water.

The introduction of insecticides should have had a positive effect on alfalfa seed yields. However, some farmers in the area indicate that careless use of chemicals may have reduced the number of pollinators to the extent that seed yields were decreased. It is not likely that this is a trend which will persist. If insecticides have resulted in increased alfalfa seed yields, these increases have been more than absorbed by other negative factors. Thus, all these reasons suggest that there is no firm evidence that capital or technological factors could have accounted for the difference in rental prices of water.

The Statistical Results

A multiple regression model was used to determine the effect of the explanatory variables on the rental price of water. Scatter diagrams of the dependent variable and some of the explanatory variables suggested that transformations of the variables to logarithms would give better fits. The equation estimated was

$$\log Y = \alpha + \hat{\beta}_1 X_1 + \hat{\beta}_2 \log X_2 + \hat{\beta}_3 \log X_3 + \hat{\beta}_4 \log X_4 + \hat{\beta}_5 X_1 \log X_2 \\ + \hat{\beta}_6 X_1 \log X_3 + \hat{\beta}_7 X_1 \log X_4 + \gamma$$

where

Y is the annual real rental price per acre-foot in dollars (column 2, Table 1),

X_1 is the transfer arrangement (column 3, Table 1),

X_2 is the water availability per irrigated acre, in acre-feet (column 4, Table 1),

X_3 is the real expected price of alfalfa seed per cwt., in dollars (column 5, Table 1),

X_4 is the real expected price of livestock per cwt., in dollars (column 6, Table 1), and

γ is the statistical error.

The inclusion of the interaction terms containing $X_1 \log X_2$, $X_1 \log X_3$, and $X_1 \log X_4$ was necessary to make the covariance test on the slopes of D_0 and D_1 mentioned earlier in connection with Figure 3. If the coefficients of the interaction terms $\hat{\beta}_5$, $\hat{\beta}_6$, and $\hat{\beta}_7$ are nonsignificant, then the slopes of D_0 and D_1 are not significantly different, and the antilog of $\hat{\beta}_1$ will represent the change in water rentals due to the shift in transfer policy.

The regression coefficients for the interaction terms ($\hat{\beta}_5$, $\hat{\beta}_6$, and $\hat{\beta}_7$) were not significantly different from zero (Table 2). The standardized regression coefficients and simple correlation coefficients were not as large as for the two significant variables, X_1 and $\log X_2$. Thus, covariance analysis of the effect of X_1 on water price is appropriate. Since the interaction coefficients were nonsignificant, a new regression equation was estimated without the interaction terms. The results for this revised regression are presented in Table 3.

Table 2. Measures of significance for independent variables

Independent variable	Regression coefficients $\hat{\beta}_i$	Calculated F value on $\hat{\beta}_i$	Standardized regression coefficient	Simple correlation coefficient
X_1	1.8618*	10.95	1.263	0.66
$\log X_2$	-1.0515*	7.70	-0.511	-.79
$\log X_3$	-0.1840	0.12	-0.056	-.57
$\log X_4$	0.7068	0.43	0.270	.28
$X_1 \cdot \log X_2$	-0.4427	1.76	-0.476	-.26
$X_1 \cdot \log X_3$	-0.0019	0.10	-0.047	-.47
$X_1 \cdot \log X_4$	-0.0323	0.30	-0.498	-.52

*Significantly different from zero at the 5-percent level.

Table 3. Measures of significance for independent variables without interaction terms

Independent variable	Regression coefficients $\hat{\beta}_i$	Calculated F value on $\hat{\beta}_i$	Standardized regression coefficient	Simple correlation coefficient
X_1	0.6608	4.40	0.4484	0.66
$\log X_2$	-1.3350	36.72	-.6486	-.79
$\log X_3$	-0.3798	1.17	-.1154	-.57
$\log X_4$	0.1708	0.09	0.0652	0.28

The importance of water transfer policy (X_1) in explaining water prices is suggested by the regression results. The antilog of the regression coefficient in Table 2 (1.8618) is 6.43. The increase in the real rental price of water

due to transfer flexibility (at any quantity of water supply) is thus \$6.43. If the model of Table 3 is used, the regression coefficient is somewhat lower (0.6608), yielding an antilog and real water price of \$1.84.

One of the reasons for the rather large difference in $\hat{\beta}_1$ as determined by the two models is the degree of multicollinearity existing in the model containing the interaction terms. This multicollinearity results from the use of the dummy variable (which has a value of either 0 or 1) as one of the multipliers in the interaction terms. Therefore, the regression results in Table 3 would seem to be preferable to those in Table 2.

The partial regression coefficient for water availability per irrigated acre ($\log X_2$) is significantly different from zero, on the basis of the calculated F in both Table 2 and Table 3. The standardized regression coefficients and the simple correlation coefficients for this variable are also large.

Of the criteria in Tables 2 and 3, only the simple correlation coefficient indicates that the variable $\log X_3$ is important. The sign of the regression coefficient for this variable is negative, suggesting that higher alfalfa seed prices are associated with lower water rentals. One possible explanation for this result is that as the price of seed rises, the production of seed increases at the expense of the production of the first crop of hay. This pattern of production would likely decrease the demand for water. In any case, even the correlation coefficient for $\log X_3$ is not as strong as for X_1 and $\log X_2$.

The statistics used to judge significance in Tables 2 and 3 indicate that the expected price of livestock, $\log X_4$, was of minor importance in determining water prices.

Another test of the importance of the variables ($\log X_3$, $\log X_4$, $X_1 \log X_2$, $X_1 \log X_3$, and $X_1 \log X_4$) is a comparison of multiple R^2 with and without these variables. In the model in Table 2, with all variables left in, R^2 is 0.94. With only variables X_1 and $\log X_2$ left in, R^2 is reduced to only 0.89. This reinforces the evidence in Table 2 that only X_1 and $\log X_2$ are important explanatory variables. With respect to the model in Table 3, a similar result is indicated, with an R^2 of 0.893 when $\log X_3$ and $\log X_4$ are left in the model and an R^2 of 0.886 when they are left out. These high R^2 's are also evidence that other variables unaccounted for in the regression, such as technology, may not have much explanatory significance.

Concluding Comments

The transfer policy in effect and the water supply are the explanatory variables which have accounted for most of the variation in the rental price of water from 1934 to 1964. Although much of the year-to-year variation in price is explained by variation in water supply, the large difference in average rental prices between the two periods 1934-1948 and 1948-1964 is mostly explained by the fact that intercompany transfers of water were permitted after 1948.

The covariance analysis yielded a difference of \$1.84 in real water value

as between the two transfer policies, on the basis of the estimates given in Table 3. The higher rental values were associated with the policy in which intercompany transfers were made.

How is it possible that the value of marginal product of water (rental price) could be so markedly increased by permitting intercompany transfers?

First, permitting intercompany transfers increased the market area by about four times. If we assume considerable variation in efficiency of farmers and land in the area as a whole, transfer flexibility between companies might increase the productivity of water substantially.

Second, knowing that water would be available for rent would greatly reduce an important area of risk. The risk of an insufficient water supply is most important to farmers in this area. Knowing that water is available for rent might induce farmers to alter their cropping patterns. The efficient ones might produce high-value, high-water-using crops; others would save water in order to rent it out.

Finally, two of the companies have good storage capacity while the two others depend primarily on surface flow. Before intercompany transfers, water deliveries differed greatly among companies, and severe waste occurred. The transfer flexibility made the stored water available to all companies, and water efficiency in the area should have been greatly increased, both by better allocation among users and by better allocation among years. The amount of water wasted in the wet years by the companies formerly relying on surface water should thus be reduced significantly.

Statistically significant differences between the predicted rental prices under different allocative policies provides strong evidence that transfer freedom is very important to efficient allocation of resources. In view of the recent clamor for more authoritative methods of allocating water and less reliance on the market, the introduction of intercompany transfer flexibility in the study area represents a bold step in the opposite direction. The payoff in the case examined here is large and evident. It may be that similar opportunities exist throughout the West.

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Impact of Water Recreational Development on Rural Property Values*

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Public investment in water-based recreation facilities is made to increase the recreation potential of an area and to improve the economic resource base of the area. Estimates of the impact of one such investment on the structure of the land market and on property values were made for a rural area in Pennsylvania. The findings of the study support the general hypothesis that investment in water-based recreation facilities does significantly influence the value of rural property and the structure of the rural land market. Property characteristics and subdivision activity on surrounding properties had to be considered in addition to distance from the recreational development to measure the impact of this public investment.

EVALUATION of the economic contribution of recreation facilities has centered primarily on measuring fish and wildlife benefits and on determining factors which influence the extent to which such facilities are utilized [8, 10, 12]. These considerations are only part of a much broader problem. Of equal if not greater importance are the positive or negative impacts of recreational development projects on (1) employment, (2) distribution of income, (3) industrial development, and (4) the asset position of rural families in the surrounding areas. Some of these questions have been investigated [3, 7].

This article presents the results of research designed to evaluate the impact of a specific recreational park development on property assets in the nearby rural area. The study was confined to an analysis of (1) the extent to which the per-acre value of different types of properties located in the nearby area was affected by the park development,¹ and (2) the way in which the structure of the market for these properties was altered by the park development.

The Study Area

The basic data for this study were based upon transfers of properties located near a 2,250-acre water-based state park which is within 20 miles of two relatively large population centers in Pennsylvania (Harrisburg with a population of 79,697 and York with a population of 54,504). Ac-

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According to the Pennsylvania Department of Forests and Waters, this park offers year-round recreation facilities excluding skiing, has two beaches on a 340-acre lake, and has provided nearly one million user-days of recreation per year since it was opened to the public in 1961.

Data were gathered on 994 property transfers which occurred during the period 1950–1965 in the townships in which the park is located.² These data were supplemented with information on property characteristics which was available from tax duplicates, aerial photographs, and soil surveys.

Of the 994 transfers recorded, 532 were excluded from this study on the basis of evidence of extra-market factors³ influencing the transaction, and 179 were excluded because of insufficient records, insufficient title information, or inability to link the transaction to current tax map and tax duplicate data.⁴

Changes in Land Value

In evaluating the impact on property values, after the fact, of a public investment such as a water-based recreational development, it is difficult to reconstruct the situation as it would have been in the absence of the investment. One approach, exemplified by that of Knetsch [5], is to compare values of properties surrounding an existing water-based recreational development in area A with values of similar properties in area B, which does not possess such a development, and to assume that the difference between these two values is attributable to the investment. This approach requires that area A and area B be similar with respect to other conditions such as population density and growth and per capita income. As Knetsch and others [5, 6, 9] point out, this approach also requires one to assume that the value of the economic gains resulting from the project will be capitalized into the value of the surrounding properties.

An alternative approach—the one used in this study—is to compare the values of the same properties surrounding the development before and after creation of the development. This approach allows a more thorough

¹ The importance of changes in property values to the economic well-being of rural families has been studied by Boyne [2]. He estimated that the total gain accruing to owners of farm real estate in the United States from 1940 to 1960 was the equivalent of 28.3 percent of the value of farm real estate on January 1, 1963.

² Although the total number of properties in this township varies from one period to another, in 1962 there were 783 properties and in 1966 there were 886.

³ One-dollar transactions, sales of mineral and timber rights, sales of part-ownerships, transfers involving lien satisfaction, etc., were taken as evidence of extra-market activities. Additional detail will be reported in a forthcoming Pennsylvania Agricultural Experiment Station bulletin by W. A. Schutjer, R. Downing, and M. C. Hallberg, entitled "Recreational Water Reservoir Development and Rural Property Values."

⁴ The procedure for conducting a title search using the various official records is described in Downing and Schutjer [4].

assessment of the impact of the development on the values of similar properties and provides a basis for examining what changes, if any, have taken place in the structure of the surrounding land market as a result of the development.

The model used

In the present study we have used the capitalization assumption and multiple regression techniques to evaluate the impact of the park development. The data available for analysis provided an opportunity to study the differential effects of various factors on property values before and after construction of the park.

Several factors can be expected to account for variation in the per-acre value of different properties. These include variables associated with the intrinsic value of the property as well as environmental variables in the same general area. In this study the following variables were chosen to explain variation in the per-acre sale price of the bona fide property transfers:

X_1 is the month of transfer (January 1950=1, February 1950=2, etc.);

X_2 is the number of acres transferred;

X_3 is the road distance in miles to the nearest park entrance;

X_4 is X_3^2 ;

X_5 is 1 if a source of ground water in excess of five gallons per minute, can be tapped at a reasonable cost⁵ and 0 if otherwise;

X_6 is 1 if soil characteristics permit adequate on-lot waste disposal and 0 if otherwise;

X_7 is 1 if the property had an average slope of 15 percent or greater and 0 if otherwise;

X_8 is 1 if the property had soil types, surface stone, and underlying rock formations which hinder construction and 0 if otherwise;

X_9 is 1 if the property was located near a hard-surfaced road at time of transfer and 0 if otherwise;

X_{10} is the soil conservation classification indicating the potential of the property for producing woodland products⁶;

X_{11} is the proportion of the property covered by trees as estimated from aerial maps;

X_{12} is the expected corn yield per acre under good management conditions⁷;

⁵ As determined by Bourguard and Associates [11].

⁶ The range of this variable was from 1 to 29 with 1 indicating a very high potential and 29 indicating an extremely limited potential for producing woodland products [11]. The mean value of this variable for the properties in our sample was 14, the mode 11; and 63 percent of the properties had a rating of between 10 and 18.

⁷ As determined by the U.S. Soil Conservation Service [11].

X_{13} is the road distance in miles from the property to the nearest small town⁸;

X_{14} is 1 if the property was transferred after 1956⁹ and 0 if otherwise; and

X_{15} is the feet of road frontage per acre on the transferred property.

Five additional explanatory variables were defined to permit study of the effect of interactions between certain factors on the per-acre sale price after 1956:

$$X_{16} = X_3 \cdot X_{14},$$

$$X_{17} = X_4 \cdot X_{14},$$

$$X_{18} = X_{15} \cdot X_{14},$$

$$X_{19} = X_{10} \cdot X_{14}, \text{ and}$$

$$X_{20} = X_2 \cdot X_{14}.$$

The 283 transfers were divided into four classes of properties, as follows: Class I, two acres or less without buildings¹⁰; Class II, two acres or less with buildings; Class III, more than two acres without buildings; and Class IV, more than two acres with buildings. The purpose of this classification was to obtain more homogeneity than would have been provided by lumping all properties together in one group.

All 20 variables were used in a multiple regression model in which the dependent variable was deflated sale price¹¹ per acre. With this model and the variables as defined above, the effect, other things being equal, of variables X_2 , X_3 , X_4 , X_{10} , and X_{15} on the dependent variable (Y) during the periods 1950–1956 and 1957–1965 can be determined as follows (where the b_i 's are estimates from the regression):

<i>Variable</i>	<i>1950–1956</i>	<i>1957–1965</i>
X_2	b_2	$b_2 + b_{20}$
X_3	b_3	$b_3 + b_{16}$
X_4	b_4	$b_4 + b_{17}$
X_{10}	b_{10}	$b_{10} + b_{19}$
X_{15}	b_{15}	$b_{15} + b_{18}$

Thus, b_{20} , b_{16} , b_{17} , b_{19} , and b_{18} measure the difference between the effects of the respective variables in the two time periods on sales prices. Similarly, b_{14} measures the difference between the mean value of Y (after adjusting for the effects of the other variables) in the two time periods. All other parameter estimates are interpreted in the usual manner.

If one or more variables did not yield coefficients which were signifi-

⁸ These towns—three in number—were all within ten miles of the park.

⁹ This was about the time when little doubt remained that the park was to be established. This date was used instead of the date at which the park opened in order to include most of those properties purchased in anticipation of park construction.

¹⁰ Only permanent buildings were considered.

¹¹ Deflated by GNP (1958 = 100). Although this index is not the ideal deflator of land prices, it was used in the absence of a good alternative for this area.

cantly different from zero at the 20-percent probability level, the regression equation was rerun under the assumption that these coefficients were zero. Estimates of the parameters of the four equations thus computed are shown in Table 1.

Table 1. Regression results for equations explaining variance in sales price per acre of transferred properties in the park development area^a

Variable	Class of property			
	Less than 2 acres		2 acres or more	
	Without buildings (Class I)	With buildings (Class II)	Without buildings (Class III)	With buildings (Class IV)
X_1 month of transfer		81.46 (27.78)		
X_2 acres transferred	-1,089.90 (241.02)	-7,576.57 (1,855.65)	-1.13 (0.73)	-8.40 (2.82)
X_3 ground water condition			184.82 (93.48)	
X_6 waste disposal condition		3,948.84 (1,896.30)		
X_7 slope		-5,370.95 (2,173.39)		
X_8 poor construction site		-5,071.94 (1,689.92)		
X_9 near hard-surfaced road	848.20 (226.78)			609.16 (255.77)
X_{11} tree coverage		-4,244.83 (2,125.81)		935.64 (437.32)
X_{12} corn yield potential				13.10 (3.91)
X_{13} distance to nearest town	226.70 (76.28)			
X_{14} transferred after 1956		-6,775.30 (2,916.52)		
X_{15} road frontage		8.72 (3.34)		
X_{16} distance to park after 1956	-292.60 (68.38)			
X_{18} road frontage after 1956	1.10 (0.51)			
X_{19} woodland production potential after 1956	73.25 (16.60)			
Constant term	615.37 (338.60)	13,590.83 (3,414.26)	169.70 (68.30)	-302.78 (445.93)
F-Ratio	13.85	9.34	3.02	8.17
R^2	0.51	0.57	0.10	0.35
Sample size	88	66	63	66

^a Standard deviations appear in parentheses below the estimates.

Estimated effects of variables

Sales price per acre was significantly and negatively related to size of property (X_2) for all classes of properties. However, there was no signifi-

cant difference in the effect of this variable before and after construction of the park was announced.

The magnitude of the effect on sales price per acre of size of property transferred was substantially different for the various classes of properties, ranging from a low of $-7,576.57$ for Class II properties to a high of -1.13 for Class IV properties. Elasticities of demand for properties in each class provide an alternative and, for some purposes, a more useful comparison of the effect of size of property transferred in each class.

Estimates of the elasticity of demand at the mean values of Y and X_2 for the four classes of properties, based on the estimates of b_2 shown in Table 1, are as follows:

Class I	$-1.42,$
Class II	$-1.69,$
Class III	$-3.38,$
Class IV	$-2.68.$

The elasticity estimates for Class II and Class IV properties may be biased, since no attempt was made to account for differences in the quality of improvements.¹²

The relatively high elasticity of demand for Class III and Class IV properties probably reflects the fact that more alternative forms of investment with which to obtain the same amount of satisfaction are available to prospective buyers of Class I and Class II properties. Thus, such buyers would be expected to be more responsive to price changes than would buyers of tracts of two acres or less.

In general, one would expect the elasticity of demand for properties without buildings to be greater than the elasticity of demand for properties with buildings (in the same size-class) at any given value of X_2 , assuming that buyers do not attach a negative value to buildings.¹³ The elasticities presented above, however, were evaluated at the mean values of X_2 , which were, respectively, 0.81, 0.76, 49.23, and 38.51 acres. Thus, it would be difficult to argue uncategorically that the elasticity derived for, say, Class I properties should be greater than the elasticity derived for Class II properties. Intuitively, the reverse might well be argued, on the theory that buyers of small properties with buildings would be more responsive to price changes than would buyers of properties without build-

¹² Differences in the quality of the land were accounted for, at least in part, by the remaining variables in the regression equations. All four estimates may be biased for a different reason, however, and thus should be used with some reservation. The four equations were estimated under the assumption that the supply of each class of land is an exogenously determined variable. This assumption, as the section of this article entitled "Land Market in the Study Area" will demonstrate, is not necessarily true and hence an identification problem may be present—that is, what we have estimated may not, in fact, be demand functions.

¹³ Assuming also that the slope of the demand function for properties with buildings is less (that is, more negative) than the slope of the demand curve for properties without buildings.

ings, because of the possibility that the buildings would be undesirable for their purposes and might even necessitate an expenditure for their removal.

Distance from the park.—The coefficient on distance from the park for properties sold before or during 1956 (b_3) was not significantly different from zero for any of the four classes of properties transferred. This is what might be expected, because there was no certainty about establishment of the park until 1957.

The coefficient on distance from the park for properties sold after 1956 (b_{16}) was significantly different from zero for Class I properties. The size and sign of this coefficient (-292.6) indicates that, other things being equal, the sales price of Class I properties transferred after 1956 was about \$292.60 lower for every additional mile of distance from the park.

Distance from the park had no significant influence on the deflated sale price per acre of Class II, Class III, or Class IV properties either before or after announcement of park construction. Nevertheless, the mean values of the deflated sale price per acre of Class II, Class III, and Class IV properties transferred between 1957 and 1965 were respectively 12 percent lower, 192 percent higher, and 15 percent higher than values of the same classes of properties transferred between 1950 and 1956. A plausible explanation for the decline in value per acre of transferred Class II properties is that these properties had the types of improvements which were undesirable for site developments near the park.

Owners of the larger tracts, particularly of unimproved properties, appear to have fared much better. Analysis of subdivision activity of the Class III and Class IV properties suggest the primary reason.

The land area in the township under study was divided into seven zones—the i th zone representing a range of driving distance from the main entrance to the park of between $i - 1$ and i miles. Data on subdivision activity in each of these zones is given in Table 2. These data suggest that the park has resulted in greatly expanded subdivision activity in those areas near the park. Thus, not only has the impact of the park been reflected in the general level of real estate prices for large properties, but also owners of these properties have benefited through the increased opportunity of selling (unimproved) parcels of land in two acres or less.

Other property characteristics.—The only factors significantly related to the per-acre value of Class III properties were size of tract and whether or not a good source of water existed on the property. Class IV properties generally sold for a premium if they were located on a hard-surfaced road, were heavily forested, and had a high corn yield potential.

Class II properties generally sold for a premium if they possessed characteristics of a good residence site—that is, if they had good drainage capabilities, were not steeply sloped, were capable of supporting buildings,

Table 2. Number of subdivisions which resulted in Class I properties, and percentage of all land area by zonal distance from the park, 1950-1965

Zone	Number of subdivisions			Percentage of total land area in township ^a
	Before 1950	1950-1956	1957-1965	
0.0-1.0 miles	8	3	18	4.5
1.1-2.0 miles	4	4	10	17.7
2.1-3.0 miles	1	3	7	18.9
3.1-4.0 miles	1	3	4	26.8
4.1-5.0 miles	1	1	9	15.8
5.1-6.0 miles	4	1	2	11.9
6.1-7.0 miles	1	3	0	4.3
All zones	20	18	50	99.9

^a Excluding the park area.

and had relatively large frontage. This, of course, is to be expected, since most of these properties are used for residential purposes.

Class I properties located on a hard-surfaced road, other things being equal, sold for \$848.20 more per acre than did properties located on an unimproved road. After 1965, these properties sold for a premium of \$1.10 per acre for each additional foot of road frontage per acre.

For Class I properties, the regression coefficient for the distance the transferred property was located from the nearest small town (X_{13}) was significantly different from zero and the sign was positive. Thus, Class I properties sold at a lower price per acre, other things being equal, if they were located in close proximity to a small town.

The Land Market in the Study Area

Three aspects of the market were analyzed to determine the impact of the park on the structure of the land market in the study area: (1) the size of properties transferred, (2) land use patterns of properties transferred, and (3) property characteristics associated with market prices.

Property size

Transfers of properties of two acres or less without buildings (Class I) have increased sharply in the study township since 1956. A comparison of transfers in the study group with other properties indicates that the number of transfers per year of two-acre-or-less tracts without buildings increased by more than 150 percent between the periods 1950-1956 and 1957-1965, whereas average annual sales of Class II, III, and IV properties increased only 80 percent.

The increase in number of Class I properties transferred in the study area appears to be closely related to the establishment of the park. The data presented in Table 3 provide information regarding the distribution of the transfers of Class I properties both between time periods and by zonal distance from the park area.

Table 3. Number of transfers of Class I properties, and these transfers as a proportion of all property transfers by zonal distance from the park, 1950-1956 and 1957-1965

Zone	1950-1956		1957-1965	
	<i>number</i>	<i>percent</i>	<i>number</i>	<i>percent</i>
0.0-1.0 miles	3	15.0	26	48.2
1.1-2.0 miles	6	33.3	12	36.4
2.1-3.0 miles	3	17.6	8	25.0
3.1-4.0 miles	3	25.0	5	20.0
4.1-5.0 miles	1	20.0	10	41.7
5.1-6.0 miles	4	26.7	3	12.3
6.1-7.0 miles	4	50.0	0	0.0

The heavy concentration of property transfers in zones closest to the park in the period 1957-1965 suggests not only that distance from the park is related to transfers of Class I properties but also that the increased sales activity associated with these tracts occurred after announcement of the park.

Land use patterns

Data regarding changing land use patterns for the period 1950-1965 were not available from secondary sources. However, it was possible to determine the current land use (that is, at time of transfer) of properties sold between 1962 and 1965 from Tax Duplicates. The data given in Table 4 indicate that residential properties accounted for more than 60 percent of all properties transferred during the period 1962-1965.

The data in Table 4 also suggest that as distance to the park increases—a movement from Zone 1 through Zone 7—the proportion of properties used as residential sites decreases and the proportion of transferred properties currently utilized in agricultural pursuits increases.¹⁴ These data suggest that there has been a shift in the structure of the land market toward an increase in the proportion of transfers accounted for by residential land.

¹⁴ A simple regression yielded the following:

$$Y = 93.4 - 7.5X \quad (R^2 = 0.77)$$

where Y is the percentage of transferred properties currently in a residential category and X is the zonal location of transferred properties.

Table 4. Property transfers by land use category and by zonal distance from the park, 1962-1965

Zone	Land use category		
	Residential ^a	Agricultural ^b	Other
0.0-1.0 miles	26	0	0
1.1-2.0 miles	22	5	3
2.1-3.0 miles	28	10	7
3.1-4.0 miles	36	22	3
4.1-5.0 miles	16	14	5
5.1-6.0 miles	10	8	2
6.1-7.0 miles	7	6	1
All zones	145	65	21

^a Includes residential and small lots; however, the Tax Duplicate Classification names tracts of less than two acres as "small lots."

^b Includes large lots and farms.

Property characteristics

In a land market characterized by a shifting land use pattern, one would expect a corresponding shift in property features which command a premium. Thus, in a land market characterized by a shift in emphasis from primarily agricultural to residential uses, there might be a relative de-emphasis of property characteristics which facilitate agricultural productivity. The variable designed to measure the agricultural attributes of transferred properties (Table 1) allows us to examine this hypothesis.

The variable selected for this use was the rating of each property on its woodland production potential as derived from soil maps (X_{10}). This rating, provided by the U.S. Soil Conservation Service, is based upon property characteristics which reflect (1) soil productivity, (2) topography, (3) drainage, (4) potential and actual erosion, (5) surface stone and boulders, (6) depth of soil, and (7) data on species priority [11, pp. 31-38]. This variable was selected for our purposes in preference to, say, expected corn yield since it includes several considerations affecting agricultural productivity.

The coefficient on X_{10} was not significantly different from zero for any of the four property classes. This finding indicates that the price per acre received for properties transferred between 1950 and 1956 was not substantially influenced by property characteristics generally favorable to agricultural pursuits. Variable X_{19} , however, which relates the woodland potential classification of properties sold after 1956 to the price per acre received, is positive and significantly different from zero for Class I properties (Table 1). Thus, in the period following 1956, a premium was paid for Class I properties with characteristics generally unfavorable for agricultural pursuits.

The reason for this outcome is no doubt that the market price for the two-acre-or-less tracts in the study area transferred before 1956 is largely unrelated to the potential agricultural uses of the properties, and that the price differential of more than \$1,000 per acre overshadows any residual relationship.¹⁵

Conclusions

The findings of this study support the hypothesis that public investment in water-based recreational areas can significantly influence the value of rural property. Moreover, an analysis of the location of properties with respect to the park and of subdivision activity on surrounding properties suggests that (1) the nature of the impact of the park varies among different properties, and (2) the park has a significant impact on the structure of the land market surrounding the park.

The fact that in this study proximity to the park did not contribute significantly to an explanation of the prices received for small properties with buildings probably reflects a shortcoming of the model. In a land market characterized by shifting land use patterns, it may be that buildings designed for one use may represent a negative influence on the value of the property in a new use. If the model were altered to separate the two components of property value—land value and building value—it might lead to results which would support the hypothesis that the land value of Class II properties is positively influenced by the park but that, because of a changing land use pattern, building values detract from the total value of the property.

In any event, it appears conclusive that an analysis of changes in property values alone will not provide an accounting of the total impact of a public investment in a water-based recreational park on the surrounding land market. Changes in the structure of this land market brought about by the investment must also be considered. This fact has significant implications for the planning of such investment projects. For example, areas in which the opportunity for substantial subdivision of large properties exists may stand to gain more than areas in which subdivision is not feasible. This, in turn, may necessitate a consideration of income redistribution effects of the investment before allocation of funds.

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¹⁵ The average price received for two-acre-or-less tracts transferred between 1950 and 1965 was \$1,250 per acre; the average price of greater-than-two-acre tracts transferred during the same period was \$188 per acre.

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Efficiency of Resource Allocation in Indian Agriculture*

GIAN S. SAHOTA

This study presents an analysis of resource allocation in Indian agriculture. Production functions are fitted to pooled data. Average and marginal productivity differences are derived for a number of inputs in the production of different crops, across different regions, and over various farm sizes. The results, on the whole, do not lead to the rejection of the hypothesis that there are comparatively few inefficiencies in resource allocation in Indian agriculture.

THE OBJECTIVE of this study is to evaluate the efficiency of Indian farmers in allocating resources available to them among different production alternatives. For this purpose, production functions were estimated and marginal productivities were derived for various agricultural inputs for different crops and farm sizes across different states in India. Much of the article is devoted to the specification, estimation, and analysis of the production function underlying the sample used. These determine the degree of accuracy with which the efficiency of resource allocation is estimated. The final evaluation of resource allocation consists mainly of comparisons between the computed marginal value products and the corresponding input prices over different dimensions. Such an analysis of the peasant agriculture of India is particularly desirable for formulating future plans for the agricultural development of the food-hungry India of today.

Empirical studies of resource allocation in Indian agriculture have recently appeared in this journal and elsewhere [5, 8, 16].¹ The present study differs from these earlier ones in the formulation of the model, the size, coverage, and dimensions of the sample used, and the span of analysis carried out.²

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¹ An earlier study of this type is Agrawal and Foreman [3].

² Hopper's study [8] is based on a cross section of 43 observations collected by the author during the latter half of 1954 in a village of Central India. Chennareddy [5] used two separate samples for the year 1957-58, consisting of 67 and 37 observations

Sources and Limitations of Data

The data for this study were taken from a government publication, *Studies in Economics of Farm Management* [11]. These studies were made for three years, 1954-55, 1955-56, and 1956-57, and for six typical regions of India. (The publication lagged by three to four years.) In each of the six regions, two contiguous districts were selected for study in such a way that they represented the most important and typical soil-crop complexes in the state concerned. These six regions taken together represent the major cropping patterns in the country.

In each of the districts, the investigation was carried out in 10 villages by the cost-accounting method and in 10 villages by the survey method, 4 of these villages being analyzed by both methods. Thus, 16 villages were selected in each district, making a total of 32 under study in each region. These surveys, with all their shortcomings, are still the most comprehensive and scientifically organized ever carried out for Indian agriculture.

All variables are in annual flows. The value measures are in rupees of 1954-55 prices. The input variables were measured separately for different crops. The major constraint on these data is that they are available on a per-acre basis only. Therefore, the production function estimates are restricted to constant returns to scale. Accordingly, the conventional test of scale economies from the sum of coefficients is irrelevant to the present study.³ The concepts and definitions of the variables used in this study are briefly discussed below.

for a district in South India. Rao's study [16] likewise is based on a small sample, in the state of Hyderabad. Similarly, Agrawal and Foreman [3] used a single cross section for a small area in West U. P. None of the above studies used more than four inputs and one dimension in the production functions. The present sample, as will be explained in the text that follows, consists of a total of over a dozen crops, for which 859 observations were compiled for the following variables: human labor, bullock labor, land sizes, seeds, and fixed capital; 579 observations for these variables and fertilizer; and 98 observations for all of these variables and irrigation expenses. Most of the data consist of three cross sections, six regions, eight farm size-groups, and dry and wet farms.

³In order to see that this statement is true, consider the three major inputs, land (x_1), labor (x_2), and capital (x_3). The production function, in simplified form, becomes

$$x_0/x_1 = B(x_2/x_1)^{\alpha_1}(x_3/x_1)^{\alpha_2}.$$

It follows that

$$x_0 = Bx_2^{\alpha_1}x_3^{\alpha_2}x_1^{(1-\alpha_2-\alpha_3)}.$$

Obviously the sum of the coefficients is unity. This homogeneity case can be generalized to any number of inputs. Still another disadvantage of using the per-acre output and inputs is that they might introduce a spurious correlation between output and the independent variables.

Table 1. Estimated production coefficients of equation

Coefficient of ^b	Regression identification					
	Overall 1	Overall 2	Overall 3	Wheat 4	Jowar 5	Bajri 6
..... rupees in constant prices						
Constant	3.309* (0.25)	4.040* (0.28)	4.436* (0.53)	■.803 (1.67)	-0.084 (1.05)	-2.76* (-0.87)
lnH	0.502* (0.06)	0.290* (0.05)	0.233* (0.11)	..	0.432 (0.34)	0.242* (0.05)
lnB	.. ^d	..	0.006 (0.07)	1.086* (0.04)	..	0.214 (0.16)
lnS	0.47* (0.02)	0.061* (0.05)	0.014 (0.02)	1.041 (0.59)	0.381* (0.23)	..
lnM	..	0.049* (0.02)	0.078* (0.02)	..	..	..
lnK	0.207* (0.05)	0.178* (0.05)	0.080 (0.67)	1.138* (0.07)	..	..
lnI	..	..	0.112* (0.03)	..	..	..
ID	0.281* (0.09)	0.258* (0.11)	..	1.399* (0.21)	0.695 (0.62)	0.696 (0.62)
FD1	-0.055 (-0.11)	-0.064 (-0.11)	..	-1.00* (-0.41)	-0.189 (-0.28)	-0.067 (-0.17)
FD2	-0.006 (-0.10)	-0.027 (-0.10)	..	-0.193 (-0.39)	-0.231 (-0.26)	-0.062 (-0.15)
FD3	-0.025 (-0.10)	-0.055 (-0.11)	..	-0.114 (-0.38)	-0.158 (-0.25)	-0.009 (-0.15)
FD4	Suppressed	Suppressed	..	Suppressed	Suppressed	Suppressed
FD5	-0.035 (-0.10)	-0.087 (-0.11)	..	0.023 (0.38)	-0.354 (-0.27)	-0.014 (-0.13)
FD6	0.085 (0.10)	0.074 (0.11)	..	-0.085 (-0.37)	-0.082 (-0.28)	-0.178* (0.14)
FD7	-0.050 (-0.11)	-0.161 (-0.12)	..	-0.187 (-0.38)	-0.167 (-0.26)	0.127 (0.15)
FD8	0.084 (0.12)	0.007 (0.12)	..	0.079* (0.40)	-0.176 (-0.29)	-0.261* (-0.16)
RD1	-0.906* (-0.13)	-0.491* (-0.15)	0.056 (0.14)	..	..	..
RD2	-0.874* (-0.12)	-0.548* (-0.14)	-0.061 (-0.12)	..	..	..
RD3	-0.839* (-0.16)	-0.759* (-0.17)	-0.212 (-0.63)	0.946 (0.68)	..	-0.542* (-0.11)
RD4	-0.561* (-0.16)	-0.927* (-0.13)	0.021 (0.13)	0.193 (0.59)	..	Suppressed
RD5	0.636* (0.12)	0.577* (0.12)	0.033 (0.14)	..	..	..
TD1	0.154* (0.08)	-0.021 (-0.08)	0.004 (0.01)	0.013* (0.003)	0.095 (0.07)	0.019 (0.01)
TD2	-0.082 (-0.08)	-0.144* (-0.08)	-0.002 (-0.03)	0.021 (0.04)	0.019 (0.06)	0.043 (0.03)
SEE	0.786	0.681	0.393	1.118	0.088	0.181
R ²	0.512*	0.518*	0.596*	0.493*	0.987*	0.919*
\bar{R}^2	0.499*	0.503*	0.545*	0.421*	0.983*	0.852*
d	0.821	0.913	1.96*	1.275	1.271	1.736*
d.f.	840	559	87	124	17	16
Land ^o	0.24* (0.11)	0.422* (0.10)	0.477 (0.60)	0.735 (0.76)	0.187 (0.47)	0.544 (0.49)

^a The numbers in parentheses are the estimated standard errors. The coefficients that are significantly different from zero at the 10-percent or lower level of the *t* test are marked with an asterisk. Note, however, that while the coefficients of the real (nondummy) variables are tested against zero, the significance levels of the coefficients of dummy variables are tested against zero and one another. Thus, the dummy coefficients that are different from at least one other dummy coefficient at the 10-percent level of the *t* test are marked with an asterisk. Such coefficients are distinguished by a prime sign on the respective standard error.

^b The symbols for real variables are defined in the text. The additional symbols are defined as follows:

ID is the irrigation dummy for wet farms as against dry farms.

FD is the farm size-group dummy. There are eight farm size-groups, which are numbered in ascending order.

RD1 is the regional (state) dummy for West Bengal, district Hooghly.

RD2 is the regional (state) dummy for West Bengal, district 24-Pargana.

RD3 is the regional (state) dummy for Bombay, district Ahmednagar.

RD4 is the regional (state) dummy for Bombay, district Nasik.

RD5 is the regional (state) dummy for Madras.

RD6 is the regional (state) dummy for Uttar Pradesh (UP). This dummy was suppressed (that is, no artificial variable was created) in all cases where UP grew the crop(s) under study. Otherwise, one other state growing the crop concerned was suppressed. Logically, only those states that grew the crop of the regression could be assigned dummies.

TD1 is the year dummy for 1955-56. (The dummy for the year 1954-55 was suppressed.)

TD2 is the year dummy for 1956-57.

ln is natural log. Log_e instead of log₁₀ was used in order to make the interpretation of the dummy coefficients convenient. Thus if the dummy coefficients are multiplied by 100, they will indicate the percentage output effect of the unit that is represented by the dummy concerned.

1), Indian agriculture, 1954-55 through 1956-57^a

and number

Gram 7	Aus Paddy 8	Aman Paddy 9	Pulses 10	Potatoes 11	Jute 12
..... maunds per unit of input					
1.210 (2.24)	-2.37 (-1.47)	1.786* (0.55)	-1.585 (-0.97)	1.592* (0.73)	0.748 (0.73)
..	0.981* (0.45)	..	0.279* (0.06)	0.120 (0.15)	0.304* (0.16)
0.054 (0.08)	0.116 (0.37)	0.063 (0.08)	..	0.337* (0.09)	..
0.148 (0.27)	0.09 (0.05)	0.101 (0.04)	..	0.030 (0.13)	..
..	0.142 (0.74)	0.220 (0.08)	0.055* (0.01)	0.352 (0.21)	0.161* (0.05)
0.281 (0.52)	0.068 (0.24)	0.068 (0.24)	0.068 (0.24)	0.068 (0.24)	0.068 (0.24)
-0.377* (-0.70)'	-0.790 (-0.70)	0.020 (0.08)	-0.300* (-0.25)'	-0.218 (-0.19)	-0.005 (-0.17)
0.056 (0.62)	-0.884 (-0.62)	0.006 (0.09)	-0.127 (-0.26)	-0.273 (-0.19)	0.102 (0.15)
-0.246 (-0.60)	-0.601 (-0.65)	0.094 (0.08)	0.028 (0.25)	-0.196 (-0.19)	0.136 (0.15)
Suppressed	Suppressed	Suppressed	Suppressed	Suppressed	Suppressed
0.337* (-0.65)'	-0.215 (-0.61)	0.135* (0.08)'	0.102 (0.26)	-0.169 (-0.20)	0.170 (0.15)
-0.367* (-0.62)'	-0.537 (-0.62)	0.241* (0.08)'	0.347* (0.28)'	-0.141 (-0.20)	-0.020 (-0.15)
1.15* (0.61)'	-0.281 (-0.78)	-0.002* (-0.006)'	0.192 (0.34)	-0.261 (-0.27)	-0.06 (-0.13)
0.013 (0.65)	0.145 (0.16)	0.020 (0.08)'	0.624 (0.44)'	-0.144 (-0.22)	0.091 (0.18)
..	-0.066 (-0.05)	0.089* (0.05)'	-0.289 (0.19)	-0.014 (-0.16)	-0.149 (-0.11)
0.239 (-0.32)	Suppressed	Suppressed	Suppressed	Suppressed	Suppressed
Suppressed	..	..	..	..	..
..
0.019 (0.58)	-0.038 (-0.04)	0.078 (0.06)	0.011 (0.02)	-0.017 (-0.02)	-0.019 (-0.01)
0.043 (0.03)	-0.066 (-0.05)	0.020 (0.06)	-0.027 (-0.22)	-0.023 (-0.02)	-0.083 (-0.15)
1.198	1.492	0.198	0.607	0.375	0.335
0.149	0.243	0.406*	0.469*	0.579*	0.676*
-0.099	0.080	0.302*	0.353*	0.435*	0.601*
2.111*	1.915*	1.491*	1.362	2.005*	2.170*
47	64	79	63	40	59
0.798 (1.05)	-0.213 (-0.23)	0.616 (0.06)	0.167 (0.27)	0.031 (0.05)	0.535 (0.75)

SEE is the standard error of estimate.

R² is the coefficient of determination.

R² is the same coefficient corrected for degrees of freedom used up.

d.f. is degrees of freedom.

d is the Durbin-Watson test statistic; it was calculated by taking into consideration the residuals for the time and size-holding

mensions only.
^a The coefficient of land is the *derived coefficient* and not a direct coefficient: that is, it was not computed directly from the regression. Instead, it was derived by subtracting from unity the sum of the coefficients of the real variables included in the regression. This method of computation was necessary, as noted in the text, because the data were available on a per-acre basis only. If implication, the coefficient of land becomes a residual coefficient, attributable, in part, to those variables (also) that may be it out but are correlated with land. The standard errors for land coefficients were computed by approximating the standard errors of the derived land coefficient from the standard errors of the computed coefficients. Specifically, the standard error of the ad coefficient is

$$\left[\sum_k s_{ak}^2 + 2 \sum_{k \neq k'} \text{cov}(\alpha_k \alpha_{k'}) \right]^{1/2},$$

th k times the number of degrees of freedom in the respective regressions.

^d Variable not available or not relevant, indicated by two dots.

Output (X_0) is annual output per acre of the crop concerned, in physical quantities (maunds) for individual-crop regressions and in value terms (rupees in 1954-55 prices) when more than one crop was dealt with in the same regression.

Human labor (H) is the value of human labor per acre. The measure of human labor includes hired labor, net labor exchanged, and family labor. Labor spent on common activities—like the upkeep of farm live-stock (imputed on the assumption that a whole-time adult worker can tend to ten adult animals)—was apportioned on the basis of the relative number of bullock-labor days spent on each crop.

Bullock labor (B) is the value of bullock labor per acre. The measure of bullock labor, like that of human labor, includes labor hired or exchanged. The value of manure produced by the draft animals was deducted from the total cost of their maintenance.

Fixed capital (K) is interest and depreciation on the value of fixed capital less the interest and depreciation on irrigation wells (where irrigation expenses were used as a separate measure) per acre. For various adjustments made in measuring capital as defined here (for example, calculation of depreciation, implicit interest, and allocation of the cost of implements to different crops) see *Studies in Economics of Farm Management: Punjab 1954-55* [11, pp. 207-209].

Land (L) is measured in acres. In most of the regions, data are given for eight farm size-groups. For Bombay, for instance, the eight farm size-groups are, in acres, 0-5, 6-10, 11-15, 16-20, 21-25, 26-30, 31-49, and 50 and over. The size-groups, however, are not identical in all states. In West Bengal, for instance, they run 0.01-1.25, 1.26-2.50, and so on. In some of the regressions that included data for more than one state, therefore, the corresponding size-groups in sequence were assumed to have, by and large, the same economic value. Accordingly, dummies were used for the corresponding serial number of size groups in each state. (See also fn. c to Table 1.)

Seeds (S) is the value of seeds per acre.

Fertilizer (M) is the value of fertilizer (and manure) per acre.

Irrigation (I) is irrigation cost, but data are not available from all regions, years, or crops. Where data were available, the cost was computed from two items: (a) Depreciation, repairs and maintenance, fuel oil and lubricants, etc., for wells, persian wheels, and pumping sets. In these reports, the manual labor and bullock labor engaged on such irrigation was not included under this item but under human and bullock labor as such. To this extent, therefore, the returns to human and bullock labor will be underestimated and those to irrigation overestimated. (b) Water rates levied by the government for the use of canal water. There are scheduled rates for different crops. In the regressions of the present study, when the

irrigation data were available and used as a separate variable, the input of "fixed capital" was net of irrigation capital.

The Econometric Relations

In this study, the data for three cross sections, eight farm size-groups, and six regions were pooled. In a few regressions, the data over crops and different seasons were also pooled. The year, size, region, and season dummies (where relevant) were introduced in the regression equations with a view to accounting for the specific characteristics of individual units of the time periods and various cross sections.⁴ The pooling of data and the use of the dummy method have the advantage of increasing the precision of estimates (1) by a possible reduction of simultaneous equations bias by taking care of various specification errors and thereby eliminating the systematic components of the correlation between the disturbances and the independent variables, and (2) by providing a larger number of degrees of freedom than in the case of nonpooled or aggregate data of a given sample. Furthermore, these procedures provide relatively more stringent tests of various hypotheses, particularly in a multidimensional study like this.⁵

The marginal products were derived from the fitted Cobb-Douglas production functions. In order to account for different dimensions of the sample, two regression models were formulated: one with what may be called the *intercept-shifting* dummy variables, which allow for different year intercepts and region and farm-size correlates, and the other with what may be called the *slope-shifting* dummy variables, which were used to allow for different slope coefficients in different seasons for those crops which are grown more than once in a year. In the present study, the latter method was applied only to paddy in the state of Madras, where this crop

⁴The dummy method involves a particular type of analysis of covariance and is in common use now. For statistical properties and mechanics of use of this method, see Goldberger [6, pp. 218-227], Suits [25], and Tomek [26]. For its application to the production function estimates, see Griliches [7] and Sahota [19].

⁵The disadvantages of the dummy method may also be noted. In the process of separating the individual characteristics of different sets of units, the procedure involves taking out the "between-class" variance of the variables and leaving only the "within-class" variance components to be used to find the regression slopes. This may cause larger standard errors of the nondummy-variable coefficients and, in the case where the variables may be measured with errors, may (by magnifying the ratio of error to systematic component variance) bias the variable coefficients downward. The superiority of the pooled regressions over the nonpooled regressions, thus, may differ from sample to sample. Elsewhere, I carried out an (empirical) analysis in depth of a similar problem and found the pooled regressions and the dummy method to give slightly superior results [18, Appendix D]. Similar comparative study cannot be done in the present case as, in several of the individual-crop regressions, the nonpooled samples have very few observations. Where relevant, however, some such comparisons will be made.

is grown three times in a year. The two forms of the production function (which were fitted to individual crops as well as to pooled crops) are

$$(1) \quad X_{0frt} = \sum_{k=1}^K X^{\alpha_k}_{kfrt} \exp \left[A + \sum_{f=2}^F b_f D_f + \sum_{r=2}^R c_r D_r + \sum_{t=2}^T d_t D_t + u_{frt} \right]$$

and

$$(2) \quad X_{0ftw} = \sum_{k=1}^K \sum_{w=1}^W X^{\alpha_{kw}}_{kftw} \cdot \exp \left[A + \sum_{f=2}^F b_f D_f + \sum_{t=2}^T d_t D_t + \sum_{w=2}^W \delta_w D_w + u_{ftw} \right],$$

where f , r , t , and w stand for farm size, region, year, and season (weather) respectively ($f = 1, \dots, F$; $r = 1, \dots, R$; $t = 1, \dots, T$; $w = 1, \dots, W$), X_0 is output, and the X_k 's are the k inputs. The α 's are the real-variable coefficients which, along with A , b_f , c_r , d_t , and δ_w , are to be estimated. The exponential parts contain three sets of what we have called the intercept-shifting dummies in both models. These are zero-one variables; that is, they take the value of one for the observations being considered and zero for the remaining observations of the same class. For instance, the D_f 's are the farm-size dummies that take the value of one for the farm-size holding under consideration and zero for other holdings. The term A is a general intercept term which, as the model is specified, stands for the omitted dummy in each class. The terms u_{frt} and u_{ftw} are error terms that are assumed to have zero mean and constant variance.

The basic difference between (1) and (2) is that the same slope coefficients, α_k , have been imposed on all classes in (1), whereas different slope coefficients for different seasons, α_{kw} , have been allowed in (2). The α_{kw} were computed from what we have called the slope-shifting dummies. That is, the data were key-punched in such a way that the variables under reference take the actual values for the season concerned and zero for other seasons.

The marginal product of the k th input in the production of crop c in season w and in the f th farm size, r th region, and t th year, where relevant, was derived from the respective production function estimates by the relation

$$(3) \quad \left(\frac{\partial X_{0cw}}{\partial X_{kcw}} \right)_{frt} = \alpha_{kcw} \left(\frac{\hat{X}_{0cwfrt}}{\bar{X}_{kcwfrt}} \right),$$

where \hat{X}_{0cw} is the level of output estimated from the production function for crop c and season w by holding each input at its geometric mean, and \bar{X}_{kcw} is the geometric mean of the k th input in crop c and season w , to which the coefficient α_{kcw} corresponds.

Since the inputs other than land are measured in value terms (annual flows in constant rupees), the calculated marginal products when multiplied by the prices of the respective products will be in rupees per rupee of input cost (both annual). For land, the same measure will be rupees per acre per year. It may also be remarked that the value measure of inputs may, to a large extent, be expected to take the input-quality differences among regions into account. Accordingly, in the case of the inputs other than land, the criterion used in this study to assess the efficiency of resource allocation is to test the marginal value products (MVP) against unity and one another; that is

$$(4) \quad \text{MVP}_{k\text{cwfrt}} = \alpha_{k\text{cw}} \left(\frac{\hat{X}_{0\text{cwfrt}}}{\bar{X}_{k\text{cwfrt}}} \right) p_{x_0\text{cwfrt}} = \beta,$$

where p_{x_0c} is the price of the output X_0 of crop c .⁶ The strictest test is provided when $\beta = 1$. When we allow for market imperfections, constraints on total expenditures for inputs, lagged responses, weather vagaries under which the farm business is carried out in India, and similar limitations, if present, a less stringent proportionality test will apply in which β can be different from unity.⁷ Both of the tests will be applied. It is apparent that the criterion of (4) applies to MVP's of all inputs and units *within* classes as well as *between* classes.

Empirical Results

Production functions

The regressions of (1) were run for over a dozen different crops. The zero-order correlation matrix of the variables indicated disturbingly high intercorrelations among human labor, bullock labor, and seeds in some of the regressions. In a few of such regressions, the coefficients of bullock labor and seeds turned out to be negative, and significantly so in two regressions. Regressions of the same data without the dummy variables slightly improved the significance levels of some of the coefficients but did not change the signs. It is possible that multicollinearity was, partly, the cause of the computed negative sign. Another possible reason could be bad crops due to pests or the failure of rains. For instance, often more plowing and dressing (requiring more-than-normal bullock labor) are

⁶ The same test will apply to land when the MVP of land is divided by its annual rent per acre in the respective units of the sample.

⁷ The MVP's are subject to standard errors, which were approximated by the relation

$$\sqrt{V(\alpha_k) (\hat{X}_0 / \bar{X}_k)^2},$$

where $V(\alpha_k)$ is the variance of α_k and the other notations are the same as defined in the text.

needed to preserve soil moisture when the pre-sowing rains are not adequate. Errors of measurement in the data for some of the crops could be a third reason. Since none of these causes has economic significance—multicollinearity is only a statistical problem, failure or inadequacy of rains is an exogenous and unpredictable factor, and errors of measurement are pure errors—the negative coefficients, particularly in the context of a Cobb–Douglas production function, were regarded as absurd. In some cases, new regressions were run by dropping the variables that acquired negative coefficients.⁸ In a few cases, the regressions in which the standard errors of the coefficient were so large that no more than one real-variable coefficient at most turned out to be significant were dropped altogether, especially when they were accompanied by a very low d statistic.⁹ The remaining regressions are reported in Table 1.

Table 1 contains three overall regressions—1, 2, and 3—and nine regressions for individual crops. The logical adequacy of the overall regressions is not unquestionable, for different crops may be produced under different production functions across the states. Besides, their statistical fit is no better than a majority of the individual-crop regressions. It is true that the R^2 's of these regressions are significantly different from zero at the 1-percent level (so also are all individual-crop regressions except two)

⁸ Since the coefficient of land is derived as a residual from the rest of the coefficients (by virtue of the homogeneity restriction), it is reported, even though negative and nonsignificant in a couple of cases.

⁹ The d statistic, in part, provides a test of errors of measurement [12, pp. 148–150]. The Indian Farm Management Surveys data have often been suspected of errors of measurement. This suspicion, perhaps, is one of the reasons why production function studies using these data have scarcely ever been published, even though numerous other studies using simple arithmetic calculations from the same data have been made [1; 2; 4; 13; 14; 16; 21; 22, p. 441; 23; 24]. It may be remarked that in case the data contain measurement errors the arithmetic calculations cannot be relied upon to yield less unbiased results than those obtained by high-powered estimation. At least, measurement errors in the dependent variable, output, will not bias the estimators obtained by the regression method [12, p. 156] whereas they may cause bias in the case of simple arithmetic calculations. Moreover, the biasedness and inconsistency that may result from measurement errors in the reported regressions will not alter the relative elasticities among the explanatory variables (though all will be nearly uniformly underestimated) if the variances of the measurement errors in all of the independent variables are, by and large, equal. If the conditions of the preceding statement hold, the coefficients of the included variables in the present study will be uniformly underestimated and, *pari passu* (because of the homogeneity restrictions of the production function of this study), the residually obtained coefficient of land will be overestimated. Going back to the d statistic, moreover, as Griliches has pointed out [7, p. 970], in the present methodology part of the effect of measurement errors is likely to be transferred from the residuals to the dummy coefficients. Hence, the resulting d statistic should be improved. If the magnitude of the d statistic is still very low—in production functions, serial correlation invariably implies small values of d —then the use of it as an additional criterion in rejecting some of the absurd-looking results seems to be a logical measure consistent with the general impression regarding the data being subject to measurement errors.

and the standard errors of estimate (SEE's) are lower than those of several other of the individual-crop regressions. This is partly by virtue of a much larger number of degrees of freedom in the overall regressions (839, 559, and 87, respectively, in regressions 1, 2, and 3). Nevertheless, in production functions, even a highly significant R^2 is not enough if it leaves a significant portion of the variation of output unexplained. Thus, the overall regressions explain at most from about 51 to 60 percent of the variations, leaving from 40 to 49 percent unexplained. On the other hand, some of the individual-crop regressions explain up to 99 percent of the variations. Nevertheless, the knowledge provided by the overall production functions is also useful, in that more of the coefficients turn out to be significant; and these production functions provide additional information with regard to the region effect, as will be seen in the succeeding paragraphs, in a way in which the single-crop production functions, in general, do not. In any case, the size of the coefficients in the overall production functions matches, by and large, that of the coefficients in the alternative single-crop regressions. The two sets of production functions, thus, seem to complement each other.

Efficiency differences between regions

The coefficients of regional dummy variables are significantly different from one another in overall regressions 1 and 2. They are not significantly different in overall regression 3, which has only 87 degrees of freedom as compared to 839 of regression 1. The probable reason for the nonsignificant regional dummy coefficients in regression 3 appears to be the introduction of the (highly significant) irrigation-expense variable (instead of the wet-farm dummy of regressions 1 and 2), a step which also is responsible for the reduction in the number of degrees of freedom. The nature of the observations available for individual crops is such that, except for wheat, the regional dummies happen to be only for two districts of the same state. Although the two districts sampled in a state may represent typically different environments, in only two of the nine individual-crop regressions do they turn out to be significant.

The regional dummies of overall regressions 1 and 2 represent the regional effect as well as the crop effect. The latter effect is implicit, because different states specialize in different crops. In the sample studied here, for instance, Bombay and Uttar Pradesh are wheat-growing states, and West Bengal and Madras are rice-growing states. Keeping these two effects in mind, we may observe that Madras State comes out at the top of the efficiency list; Uttar Pradesh comes next; and West Bengal and Bombay are bracketed on the lower side of the state efficiency levels. Thus, using the arithmetical calculations as explained in footnote *b* to Table 1,

holding variable inputs constant, we find that the overall yield in Madras is about 14 to 19 percent higher and in the district of 24-Pargana, West Bengal, is about 13 to 23 percent lower than the overall yield in Uttar Pradesh (using regressions 1 and 2).

The emergence of Madras at the top of the efficiency list seemed to me to be a somewhat surprising but important result from the point of view of agricultural development, which needed to be analyzed further. Accordingly, I looked for additional evidence to check these results. One such check is provided by the data presented in Table 2. The earlier findings are, indeed, corroborated by this table. It will, for instance, be observed that during the ten-year period, 1949-50 to 1959-60, yield per acre rose by 53 percent in Madras, whereas it remained practically stationary in West Bengal. How can we explain this disparity? (1) Can it be explained by the introduction of tractors and other farm machinery? Very doubtful, because the available data do not indicate significant differences between the two states in the increase in the number of tractors and other modern farm machines, and such machinery, in any case, is still an insignificant part of the farm equipment in the two states, whereas the differences between the two states in the increase in yield are tremendous. (2) Has the increased use of chemical fertilizer been responsible for it? Fertilizer, indeed, seems to be one of the sources of the computed higher efficiency level in Madras. For instance, in the year 1954-55, when the West Bengal

Table 2. Area sown, total production, and yield per acre of paddy (rice), West Bengal and Madras compared, 1949-50 through 1959-60^a

Year	West Bengal			Madras		
	Area	Pro- duction	Yield per acre	Area	Pro- duction	Yield per acre
	<i>thousand acres</i>	<i>thousand tons</i>	<i>pounds</i>	<i>thousand acres</i>	<i>thousand tons</i>	<i>pounds</i>
1949-50	10,608	3,964	837	4,722	1,767	828
1950-51	10,638	4,224	889	4,265	1,685	888
1951-52	10,306	3,802	826	4,449	1,786	899
1952-53	11,007	4,229	861	4,239	1,686	891
1953-54	11,327	5,556	1,099 ^b	5,097	2,554	1,122
1954-55	10,502	4,054	865	5,335	2,736	1,149
1955-56	10,846	4,444	920	5,491	2,954	1,209
1956-57	10,846	4,573	944	5,538	3,203	1,255
1957-58	10,791	4,185	870	5,696	3,134	1,252
1958-59	10,532	4,059	854	5,726	3,406	1,330
1959-60	10,916	4,172	856	5,712	3,298	1,300

^a Average yield per acre for the whole country during the reference period was 748 lbs.

^b This was an exceptionally good monsoon year in West Bengal.

Source: Government of India [9].

farmers used manure and fertilizer worth only Rs. 6.00 per acre, the farmers in Madras spent Rs. 39.90 per acre on this input.¹⁰ Currently, Madras consumes about 20 percent of the ammonium sulphate and about the same proportion of superphosphates (the two major fertilizers consumed in India) distributed in the whole country. This comes to 0.46 ton per 100 acres of gross cropped area in Madras as against 0.15 ton in all of India [15]. However, fertilizer may explain the computed differences in those regressions for which no observations on fertilizer inputs are available. The Madras dummy coefficient acquires the top position even in those regressions in which fertilizer input has been used as an explanatory variable (regression 2, for example). We must look for additional determinants. (3) Do the increased irrigation facilities account for part of the difference? This question cannot be answered categorically. The irrigation coefficient (regression 3) and several of the irrigation dummy coefficients (regressions 1, 2, and 4) are positive and significantly different from zero. The Madras dummy coefficient, however, is at the top even in these regressions. The state of West Bengal gained most in irrigation during the reference period. For instance, it had the benefit of two giant river valley projects put into operation during the 1950's—the Damodar Valley project and the Mahurakshi project—which increased its canal irrigation from 1.5 million acres to 2.5 million acres during the ten-year period. But almost the entire rice acreage in Madras is irrigated, whereas in West Bengal only a small fraction of it is irrigated—less than half, even since the two river valley projects cited above came into operation. On this score, (a) the increase in yield ought to have occurred in West Bengal rather than in Madras, and (b) the absolute magnitudes of yield ought, other things being equal, to have been relatively higher in Madras in the base year. Neither of these expectations has been realized, as can be seen from Table 2. It would seem, therefore, that irrigation per se cannot perhaps be said to have played the entire or even a major role in increasing the efficiency of Madras agriculture. (4) May the observed discrepancy be due to certain nonquantifiable inputs, such as weather and regularity of rainfall, and/or to some of the measurable inputs, such as fungicides, pesticides, insecticides, and better fencing from stray animals, for which data could not be assembled in this study? Precise estimates for these inputs are not possible. But *a priori* there do not seem to be very important differences between the two states in these inputs. (5) What about education and the spread of knowledge and information? The data are hard to come by on state-level education and skill formation in India. As far as extension and community development services are concerned, there appears to

¹⁰ See *Studies in Economics of Farm Management*, Vol. I, 1954–55: West Bengal, Table 5.10; Madras, Tables 5.2–5.5 [11].

have been no difference between the two states during the reference period. Moreover, the extension services can play a proper role mainly after the new inputs and improved techniques have been made available at reasonably cheap prices. (6) Has there been, relatively, more widespread adoption of improved rice-cultivation techniques in Madras? This appears to be, indeed, the major source of the agricultural efficiency in that state. For instance, in the year 1950, the area planted to improved varieties of rice in Madras was only about 4 percent of the total acreage under paddy [10]. During the First Five-Year Plan, nearly 50 percent of the area under rice cultivation was sown with improved seeds. By the end of the Second Five-Year Plan, 100 percent of the area was using improved strains [15, p. 75]. The Japanese method of rice cultivation is of very recent adoption in India. The area under this method of cultivation was 400,000 acres in 1953-54; it was 2.1 million acres in 1955-56. The bulk of it was in Madras.

This is the major variable omitted (because of lack of annual data for various states) from the production function estimates. Its effect is likely to have been picked up, in part, by the coefficient of the state dummy for Madras. As compared with Madras, West Bengal has been much less spectacular in the adoption of new techniques of rice sowing. To dilate upon the theories or explanations of the adoption of new techniques, however, is beyond the scope of this study.

Efficiency differences among farms of different sizes

The farm-size dummy coefficients provide possible answers to the following questions: Are the prevailing cropland resources per farm insufficient in small farms relative to those in large farms? Which of the eight farm sizes studied indicate probable relative optima for different crops? It is important to note that the differences in farm size in the present estimates signify differences only in land area, whereas the qualities and quantities per acre of the other inputs included in the regressions are held constant.

Of the 63 coefficients of the farm-size dummies (FD's) in the nine individual-crop regressions of Table 1, only 13 coefficients in four of the regressions are significantly different from one or more of the size coefficients of the respective regressions. Similar differences in the coefficients of overall regressions 1 and 2 seem to have averaged out, so that none of the size dummy coefficients are significantly different from one another. In five of the nine crops of Table 1, thus, no differences in yield due to differences in farm size are indicated. The four crops for which probabilistic differences in crop yields per acre between sizes are indicated are wheat, bajri, aman paddy, and pulses.¹¹ It will be observed that in the

¹¹ Gram crop was left out of this analysis because the R^2 for the regression of this crop is not significant.

cases of wheat and pulses the small farms (1-5 acres) seem to be using insufficient land resources per acre. The maximum per-acre yield (for identical nonland inputs) is given by the largest farms (50 acres or more). In the cases of bajri and aman paddy, the perceptible differences in yields arise only in the middle range of sizes. The trend up to the sixth size is, more or less, upward. The maximum points occur in the sixth size (26-30 acres for bajri and 7.30-8.75 acres for aman paddy). A possible inference from the size analysis, therefore, is that, with the current techniques of production, farms of more than 30 acres are, on an average, inefficient for bajri, farms of more than 9 acres or so are inefficient for aman paddy (rice), and farms of 5 acres or less are inefficient for wheat and pulses.

The above cases, as noted earlier, represent only about one-half of the crops studied. The remaining half indicate no size effect. It may be recalled that our production function is restricted to constant returns to scale. A simultaneous consideration of size-holdings and varying intensities of other farm inputs in an unrestricted production function may well reveal alternative optimalities of farm size and the overall scale. Moreover, the introduction of modern inputs like farm machinery may also alter the optimum size of farms. Finally, the present analysis relates to operational holdings and does not take into consideration tenancy conditions.

Productivity changes from one year to another

The productivity-changes variable in this model is a catchall variable for various year effects, including rainfall, weather, disproportionate changes in the omitted variables, pure technical change, and similar effects. The overall regressions provide some indication that the year 1955-56 was better than either the base year, 1954-55, or the final year of the sample, 1956-57. This is not inconsistent with the observed changes. The change of significance levels of the two year-dummy coefficients in the first two overall regressions should be noted. Thus, in regression 1, the coefficient of the year 1955-56 is significantly above zero and that of year 1956-57 is negative but not significantly. In regression 2, the coefficient of 1955-56 is practically zero, whereas the coefficient of 1956-57 is significantly below zero. In order to find a possible explanation, we may note two differences underlying these two regressions: (1) The fact that regression 2 uses a subsample (with 579 observations) of the sample used in regression 1 (with 859 observations) makes the two regressions non-comparable. (2) Regression 2 includes fertilizer (a significant variable) whereas regression 1 omits it (because of the lack of observations of fertilizer in 280 of the 859 observations). The increase in the use of fertilizer was greater than increases in other inputs in the reference years. It is pos-

sible, therefore, that the dummy variables for years picked up at least part of the effect of fertilizer in regression 1. Fertilizer shows its influence in regression 2, where the first-year dummy coefficient is reduced almost to zero whereas the second-year dummy coefficient is significantly negative.

The only other significant dummy coefficient in this group is that for wheat, which also conforms to the results found for overall regressions. None of the other crops indicates significant year effects, though the signs and magnitudes of the coefficients give a general impression that the year 1955-56 was better than the year 1956-57.

The coefficients of all of the irrigation dummies are positive but not all are significantly different from zero. Only the coefficient in the overall regression is significant at the 1-percent level. The slope coefficient of irrigation expenses, where available, is also positive and significant.

Interseason difference in slope coefficients for paddy

In order to see whether production functions and/or the intercepts may differ between seasons of the year, I ran the regression of (2) on the data for the paddy crop in Madras, which is grown three times a year in that state. The results are given below.

$$\begin{aligned}
 x_{0thw} = & [0.181H_I^*, 0.169H_{II}, 0.017H_{III}] + [0.351S_I^*, 0.291S_{II}^*, 0.023S_{III}] \\
 & (0.101) \quad (0.135) \quad (0.232) \quad (0.178) \quad (0.161) \quad (0.016) \\
 & + [0.201K_I, 0.101K_{II}, +0.098K_{III}] \\
 & (0.141) \quad (0.131) \quad (0.175) \\
 & + [2.15WD_I^*, 3.63WD_{II}^*, 3.87WD_{III}^*] \\
 & (1.070) \quad (1.653) \quad (0.568) \\
 & + [0.057FD_1 + 0.143FD_2 + 0.053FD_3, -0.021FD_5, -0.035FD_6, \\
 & (0.069) \quad (0.063) \quad (0.123) \quad (-0.140) \quad (-0.219) \\
 & \quad \quad \quad -0.029FD_7 + 0.008FD_8] \\
 & \quad \quad \quad (-0.161) \quad (0.107) \\
 & + [-0.021YD_1 + 0.014YD_2] \\
 & (-0.058) \quad (0.067) \\
 & + [0.227Land_I^*, 0.439Land_{II}, 0.862Land_{III}] \\
 & (0.115) \quad (0.269) \quad (0.563) \\
 & (R^2=0.993, \bar{R}^2=0.990, SEE=1.135, d.f.=36),
 \end{aligned}$$

where the subscripts I, II, III stand for the three seasons of the year in which paddy is grown in Madras, WD is a season (weather) dummy variable, and the numbers in parentheses are the computed standard errors. The coefficients of different variables for all the three seasons are put within square brackets to indicate that only one of the three coefficients for the season effect, one of the eight coefficients for the farm-size effect, and one of the two coefficients for the year effect have to be picked out for the production function of the indicated season, farm size, or year. The coefficient of land was derived by subtracting the sum of other coefficients from unity. It will be seen that the coefficients in each pair of brackets diverge only slightly from one season to another and in no case significantly. These results, therefore, provide no suggestion that the production functions for different seasons are different from one another.

Marginal value products

Table 3 presents the calculated marginal value products of the coefficients of real variables. Only those coefficients and regressions have been included that were found to be significantly different from zero in Table 1. Since the coefficients of the dummy variables for farm size in the overall regressions, as noted earlier, possibly represent mainly the crop effect (whereas we have separate production functions for individual crops), the MVP's from these regressions were calculated for the input class only, and are given in Table 4. Taking up the individual crops (Table 3) first, we see that the main comparisons are between inputs, between crops, and between farm sizes. Comparisons are also made between these classes. In making these comparisons, we test the hypothesis that there are comparatively few inefficiencies in the allocation of resources in Indian agriculture to different crops and to different farm sizes.

In the inter-crop inter-input comparisons, there are 2 instances out of 14 in which the hypothesis is rejected: Using the 5-percent one-tailed t test, we see that the MVP of capital in aman paddy is significantly below the MVP's of capital and other inputs in other crops, and the MVP of bullock labor in potatoes is significantly above the MVP's of several other inputs in other crops.¹² Within the farm size-groups we have a relatively

¹² These significance levels may be tested by t ratios. For example, the t ratio for the difference between the MVP of capital (denote it by MVP₁) in aman paddy and the MVP of bullock labor (denote it by MVP₂) in potatoes is approximately

$$t = (\text{MVP}_2 - \text{MVP}_1) / \sqrt{s_2^2 + s_1^2 - 2 \text{cov}(s_2, s_1)},$$

where s_2^2 and s_1^2 are the variances of the MVP's of bullock labor and capital, respectively. Since the variances as given in the table were computed for the averages of the MVP's of all the farm size-holdings in a given crop for a given input, the latter tests can be carried out by dividing the difference of two MVP's by twice its average variance. For convenience of calculation, the covariance terms were neglected. This

Table 3. Marginal value products of different inputs for different crops and farm sizes, Indian agriculture, 1954-55 through 1956-57^a

Farm size-group	Crop and input															
	4:Wheat				6:Barji				8:Aus Paddy				9:Aman Paddy			
	Bullock labor		K Fixed capital		H Hu-man labor		K Fixed capital		H Hu-man labor		K Fixed capital		S Seeds		K Fixed capital	
	Bullock labor	K Fixed capital	H Hu-man labor	K Fixed capital	H Hu-man labor	K Fixed capital	H Hu-man labor	K Fixed capital	H Hu-man labor	K Fixed capital	S Seeds	K Fixed capital	H Hu-man labor	K Fixed capital	Bullock labor	K Fixed capital
1	0.42	0.66	0.40	0.66	1.32	1.01	2.60	0.40	0.24	0.63	0.66	2.40	0.85	0.22	0.22	0.27
2	0.54	0.85	0.36	0.85	1.45	0.62	1.10	0.54	0.22	0.70	0.81	1.38	0.80	0.24	0.24	1.15
3	0.49	0.78	0.52	0.78	0.71	0.41	1.90	0.64	0.18	0.89	0.75	2.95	0.72	0.25	0.25	0.62
4	0.74	1.38	0.55	1.38	1.11	0.99	3.61	0.77	0.39	0.92	0.97	2.30	0.66	0.44	0.44	0.59
5	1.08	1.66	0.65	1.66	1.09	1.23	2.48	0.95	0.34	0.87	0.95	3.01	0.55	0.38	0.38	0.27
6	1.02	0.79	0.73	0.79	1.30	0.39	1.15	1.12	0.80	1.17	1.23	2.00	0.53	0.55	0.55	1.05
7	0.99	0.98	0.59	0.99	1.51	1.31	0.42	0.70	0.14	1.05	1.12	1.95	0.44	0.67	0.67	1.03
8	1.13	1.31	0.68	1.31	...	...	...	1.45	0.48	1.35	1.40	2.23	0.72	0.82	0.82	1.29
S_m	0.16	0.70	0.11	0.70	0.53	0.52	2.10	0.32	0.14	0.22	0.20	0.41	0.35	0.26	0.26	0.31
V_m	0.03	0.49	0.01	0.49	0.29	0.27	4.63	0.11	0.02	0.05	0.04	0.17	1.24	0.07	0.07	0.09
t_0	4.62	1.97	5.00	1.97	2.09	1.90	1.72	2.41	2.78	4.18	4.85	5.60	1.89	1.69	1.69	2.93
t_1	1.62	0.54	4.09	0.54	0.21	0.02	1.24	0.72	4.36	0.36	0.02	3.17	0.97	2.16	2.16	0.23

^a The new symbols used in this table (last panel) are defined as follows: S_m is the standard error of MVP; V_m is the variance of MVP; t_0 is the t ratio when MVP is tested against zero; and t_1 is the t ratio when MVP is tested against unity. The test statistics reported in the table pertain to the farm-size dummy 4 (FD4), which was suppressed in the regressions. (The coefficient of FD4 is represented by the general constant.) The test statistics for differences in MVP's from one another are not reported in the table but were used for discussion in the text. The values of \bar{X}_0 and \bar{X}_1 of relation (4) were calculated for different farm sizes.

Table 4. Marginal value products from the overall regressions, Indian agriculture, 1954-55 through 1956-57^a

Input	MVP as calculated from the overall regressions		
	1	2	3
	.....rupees per rupee of input per year.....		
Human labor	0.64 (0.081)	0.33 (0.100)	0.36 (0.085)
Fixed capital	0.78 (0.160)	0.60 (0.165)	..
Seeds	0.33 (0.150)	0.48 (0.170)	..
Fertilizer	..	2.69 (0.204)	0.66 (0.231)
Irrigation	..	..	3.63 (0.800)
	.....rupees per acre per year.....		
Land	15.62 (1.730)	15.47 (1.90)	..

^a The numbers in parentheses are the standard errors approximated by the formula given in footnote 7. The two dots (..) here mean that the relevant coefficients were not significantly different from zero.

higher number of violations of optimality. The MVP's that are significantly either below or above the rest of the MVP's in Table 3 are as follows:

- 4 of the MVP's (first four) for bullock labor in wheat (below);
- 2 of the MVP's (first two) for human labor in bajri (below);
- 2 of the MVP's (6 and 8) for seeds in aman paddy (above);
- 2 of the MVP's (6 and 8) for fixed capital in aman paddy (above);
- 3 of the MVP's (6, 7, and 8) for human labor in pulses (above);
- 3 of the MVP's (6, 7, and 8) for fixed capital in pulses (above);
- 2 of the MVP's (2 and 7) for bullock labor in potatoes (below);
- 3 of the MVP's (first three) for fixed capital in jute (below).

The total of such violations is 21 out of a total of 112 MVP's. Considering the MVP's of a given input across crops, we find that some of the MVP's of capital in aman paddy and some of the MVP's of human labor in jute differ significantly from the other MVP's. In this case, 2 at most out of the 14 input sets of MVP's violate the economizing hypothesis.

The test of $MVP's = \beta = 1$ for size 4 appears in the last row of Table 3, denoted by t_1 . It will be observed that 4 out of 14 MVP's are significantly different from one at the conventional levels. Out of these, 3 are below unity and 1 (bullock labor in potatoes) is above unity.

Coming to the "average" marginal products of the overall regressions (Table 4), we observe that the size of the MVP's of the inputs is, by and large, similar to that observed in a majority of cases of individual crops.

omission implies an upward bias of the calculated t ratios. This test, in any case, is only approximate. The degrees of freedom for these t tests are the sum of the corresponding degrees of freedom for the two coefficients of Table 1 from which the MVP's were calculated.

The two coefficients of fertilizer in this table (fourth row) are significantly different from each other. The one for regression 2, however, is closer than the one for regression 3 observed in Table 3, namely, the MVP of fertilizer in aus paddy. The MVP's of land are significantly close to 15 rupees per acre. Since this is an MVP for the aggregate of six regions and about a dozen crops, no single rental value can be assigned it. The only MVP of irrigation available is significantly above unity.

A rising trend of MVP's as the farm size increases is discernible, though, as seen above, it does not rise significantly in a majority of cases. The reasons for this rising trend are not far to seek. It is consistent with the observed reduction of quantities or values of inputs per acre as farm size increases. Two typical cases are presented in Table 5. It will be observed that the reduction in input intensities per acre is rather substantial. The average value of all (nonland) inputs in farms of 21 acres or more, as compared to the value of the same inputs in 0- to 5-acre farms, is approximately one-third in Bombay and a little over one-half in U.P. At the same time, Table 3 indicates (though without statistical significance) that the MVP's of large farms tend, on the whole, to be nearer unity than do those of small farms. Presumably, the farmers operating larger farms are relatively more aware of the (potential) conditions (perhaps because they are more literate) and have relatively greater scope (for example, less constraint on the availability of financial resources) for substituting among inputs and crops. It is interesting to note that even though the intensity of inputs falls so drastically in the relatively larger farms as compared with the smaller ones, the MVP's do not, in general, rise by any-

Table 5. Index of the intensity of inputs per acre by size groups, Bombay and U.P., 1956-57^a

State	Size-group	Human labor	Bullock labor	Seeds	Fertilizer & manure	Implementments	Land rent etc.	Miscellaneous	Total costs
Bombay	acres	days		rupees					
	0-5	100	100	100	100	100	100	100	100
	6-10	78	81	44	231	143	65	1	87
	11-15	46	46	38	57	80	43	20	47
	16-20	63	48	61	238	52	39	340	70
	21-over	37	41	27	34	33	43	11	34
Uttar Pradesh	0-5	100	100	100	100	100	100	100	100
	6-10	87	70	92	158	83	100	91	81
	11-15	83	59	87	94	61	112	78	72
	16-20	76	56	87	97	55	110	69	67
	21-over	61	45	80	87	47	97	66	56

^a All values are expressed in index form with the lowest farm size-group as 100.

Sources of data: Calculated from the data given in *Economics of Farm Management* [11, Vol. 3, Bombay, Table 4.1; Vol. 2, U.P., Table 3.11].

thing like the corresponding proportions. They only tend to move closer to the efficient points.

Looking more closely at the controversial marginal value productivity of human labor, we may observe (Tables 1, 3, and 4) that in 7 regressions out of 12, it is significantly above zero, though in 4 of these 7 it is also significantly below unity. In the remaining 5 regressions, the MVP of labor is not significantly above zero. *Prima facie*, then, the evidence tending to show the MVP of labor as zero or positive remains inconclusive. The evidence indicating that the MVP of a unit monetary cost of labor is positive and near unity becomes weighty, however, when the following points are taken into consideration: (1) The coefficients of labor in the five regressions left out of Table 3 are all positive. (2) A likely effect of the high multicollinearity among human labor, bullock labor, and seeds, observed in the beginning of the empirical section, is to raise the standard errors of these coefficients. (3) The introduction of a number of dummies in the regressions of this study may also have caused a slight reduction of both the significance levels and the magnitudes of the coefficients (see footnote 5). When the possibilities suggested in points 2 and 3 are coupled with the fact stated in point 1, we are led to suspect the lowness of the significance levels of the labor coefficients of these regressions. The confidence in the significance levels of the significant MVP's of labor is, *ipso facto*, heightened. Therefore, the evidence against the possibility that the marginal product of labor in Indian agriculture may be positive is, if any exists at all, very weak.

From the reasoning of the preceding paragraph, we may draw the following inferences concerning other inputs: (1) There is little evidence that investment in fixed capital in general is inadequate—in no case is the MVP of capital significantly above unity. (2) There is strong evidence of underinvestment in specific forms of capital, that is, in fertilizer and irrigation water—their MVP's are significantly above one. (3) The input of seeds seems, broadly, to conform to the conclusions derived above with regard to human labor.

Final Evaluation and Conclusions

The broad conclusions of the resource allocation analysis may now be summarized. First, however, I should remind the reader that a few of the production functions were dropped because of suspected errors of measurement and certain problems of estimation. Subject to these limitations and the probabilistic nature of estimates, the multidimensional analysis of resource allocation indicates comparatively few significant inefficiencies of resource allocation in Indian agriculture. It will be difficult to defend the often advanced assertion that the Indian farmers are tradition-ridden and not rational and "economizers," or that the marginal product of labor is

zero, and/or the marginal product of any kind of capital is high. Disequilibria do exist here and there. For instance, taking the coefficients at their face values, we find that the MVP's of fertilizer and irrigation water seem to be considerably above their costs. These, however, are inputs which it is not entirely within the capacity of individual farmers to supply. Fertilizer has to be supplied by the manufacturing sector (in India, primarily by the central government). There may be a supply constraint on fertilizer or other cooperating inputs. The learning process may be going on. The supply of irrigation water from wells is largely within the capacity of farmers as individuals. Wells cannot, however, provide the required irrigation at economical costs in every part of the country. The cost price for irrigation water used here includes charges for canal water. For some areas, canals are the only effective means of irrigation. It is possible, therefore, that the exploitation of the input of irrigation water has been held down by a lack of large-scale canal irrigation facilities. Moreover, canal water (especially the canals that form a part of river dams) may serve as a proxy for flood control and similar measures. Under such constraints the disequilibria in the use of these inputs cannot be a reflection of inefficiency on the part of farmers. The high marginal value product of bullock labor in potatoes is a major result that is difficult to explain. The relative intensity of the use of bullock labor in potatoes is comparable to that in other crops. Thus, it does not appear to be the low intensity of bullock power that has caused high MVP. It is clearly a high elasticity coefficient of this input (0.337) that seems to be responsible for it. It is possible that this coefficient picked up some of the effects of human labor. It may also be mentioned that the sampling data being analyzed belong to the final two years of the First Five-Year Plan and the beginning of the Second Five-Year Plan. These were, thus, the years during which Indian agriculture was supposedly entering a transformation stage in which the erstwhile low-level equilibrium conditions of a traditional agriculture were being transformed into the disequilibria of a developing agriculture.¹³ The subsequent experience (of the mid-sixties) shows that this disequilibrium is being corrected, at least in the case of fertilizer. Other than these relatively few exceptions, the bulk of the evidence provided by this study appears to support the hypothesis that the resources available to farmers in India have, by and large, been efficiently allocated.

¹³ According to Schultz, traditional agricultures are in a state of equilibrium whereas modern agricultures are perpetually in a state of disequilibrium [20 p. 15]. The point I am trying to make here is that possibly the conditions of disequilibrium were being created in Indian agriculture during the reference period. New seeds, chemical fertilizer, new cultivation techniques, and new incentives were being introduced and encouraged by the state; the increased investment tempo, increased use of agricultural raw materials, and changing demand for other agricultural commodities were causing shifts in such things as crop prices and yields. The observed degree of disequilibrium, therefore, is not inconsistent with Schultz's proposition.

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Projections of Age Distribution of Farm Operators in the United States Based upon Estimates of the Present Value of Income*

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The increase in the average age of farm operators in the United States since 1920 is pronounced. Several studies have been made of the age of farm operators and have projected the age distribution of farm operators in 1970. This article is based on the premise that the acquisition cost of labor of the agricultural industry for younger workers and the corresponding salvage value for older workers partially determine movements into and out of farming. Present values of future income streams for hired laborers at 25 and 45 years of age in farming and in four nonfarm occupations are estimated and used in constructing an independent variable in the farm operator supply models. Projection of the age distribution of farm operators in 1970 suggests that increases in the average age of farm operators will continue and that this trend will be more pronounced than anticipated in earlier studies.

THE increase in the average age of farm operators in the United States since 1920 is pronounced.¹ Farm operators under 25 years of age decreased from 6.1 percent of all farm operators in 1920 to 1.7 percent in 1960. For those 25-34 years old, the decrease was from 20.4 to 10.9 percent. On the other hand, the percentage of farm operators aged 55-64 increased from 15.7 percent in 1920 to 21.6 in 1960. For those over 65, the increase was from 9.3 to 17.4 percent of the total.

A study of the age distribution of farm operators is useful in formulating farm policies, for occupational and geographic mobility and willingness to take risks and adopt innovations are usually associated with the age of farm operators. Several studies of the age of farm operators have been made and have projected the age distribution of farm operators in 1970 [2, 3, 9, 13, 14]. The analysis of this article suggests that increases in the average age of farm operators will continue and that this trend will be more pronounced than anticipated in earlier studies. Estimates of the present values of future income streams in five occupations are used to project the age composition of farm operators in 1970.

* This study is part of a larger project supported by Resources for the Future, Inc., and was conducted under the leadership of Glenn L. Johnson at Michigan State University. Complete details can be found in Mr. Chennareddy's Ph.D. dissertation [4].

¹ The reason for this increase is that progressively fewer older farm operators are withdrawing from farming and fewer young adults are entering farming. One explanation for the former trend is an asset fixity theory advanced by Johnson [8, 9, 10, 11]. Imperfectly informed older farm operators, having made mistakes of overinvestment in durables in farming, can minimize losses only by continuing those durables in farming. This situation discourages many farm

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Previous Studies

Some previous projections of the number of farm operators in different age-groups are based on the hypothesis that the mobility of farm workers to nonfarm occupations is a function of the ratio of current nonfarm wage rate to the current wage rate in farming. Clawson [4] projected the number of farm operators in each age-group for 1970 by using the average net entries or net withdrawals of farm operators from one age-group to the next between consecutive census periods, based on census data from 1890 to 1960. Fox [5] first estimated for 1970 the number of commercial farms with sales of \$2,500 or more and then adjusted this figure by the ratio of commercial farms to the total number of farms in 1960 to estimate the total number of farms in 1970. Bishop and Tolley [2] projected the number of farm operators in each age-group in the United States for 1970 on the assumption that the ratio of the number of farm operators in the i th age-group in the t th census period to the number of farm operators in the $(i-1)$ th age-group in the $(t-1)$ th census period is a function of the ratio of the total number of farm operators in the t th census period to that in the $(t-1)$ th census period. One of Johnston's projections of the total number of farm operators for 1970 was made on the assumption that the estimated ratio of nonfarm wage rate to the wage rate in farming in 1960 will be the same in 1970 [12].

Method Used in This Study

The premise on which this study is based is that relative future income in farming and in nonfarm occupations plays a major role in shaping the decisions of farm workers to remain in or move out of farming. The economic rationale underlying this assumption, in general, is supported by the writings of Marshall [16, p. 311], Keynes [15], Hicks [7, p. 119], and Nerlove [17]. Bishop, in particular, states that farm workers will be inclined to transfer to nonagricultural employment if they find that the present value of future income in nonagricultural employment exceeds that in farming to the extent of more than the costs of transferring to nonagricultural employment [1]. Present values of income streams for hired laborers in farming and in four nonfarm occupations are estimated for comparative

operators from leaving the farm. In addition, older experienced farm operators who entered nonfarm occupations anticipating higher incomes tended to return to farming because, as a result of their age, low levels of education, and lack of previous nonfarm job experience, their nonfarm incomes were lower than they had expected. On the other hand, the prospects of low earnings in agriculture and the difficulties of becoming established in farming, along with the attractions of nonfarm employment and urban living, have caused a large outmovement of young adult farm operators. This situation has encouraged remaining farm operators to enlarge the size of their farms, thereby tending to eliminate inefficient farms and discouraging young and/or inexperienced persons from entering farming [26].

purposes. These present values are used in constructing an independent variable in the farm operator supply models.

Present values of income streams

Studies by Perkins [18] and Schnittker and Owens [19] show that non-farm jobs taken by most farm workers are mainly in construction, manufacturing, service industries, and wholesale and retail trade. For this study we chose farming, construction, manufacturing, laundries, and retail trade because, for these occupations, wage rates for hired laborers were available for the period 1917–1962. This time period includes World War I, the boom in the late 1920's, the depression in the early 1930's, recovery in the late 1930's, World War II, the Korean War, and the economic prosperity following the Korean War, all of which have had an impact on business activity in the United States. Since age is an important variable influencing the mobility of farm workers, two age categories were considered—15–40 years and 40 years and older. Two ages were arbitrarily selected within each group, 25 in the first category and 45 in the second. The 15–40 age-group includes most of the people who enter farming to make it their life work, while the 40-and-older group includes many of those who leave farming.

In this study, estimates of present values of future lifetime income streams are based on four components²: computed future income stream, computed unemployment rate in future years, current interest rate, and life expectancy³ of workers of specified ages.

The formula used for present value for each age category is as follows:

$$P_{it} = \sum_{k=0}^{n_t-1} \frac{\hat{W}_{i(t+k)} \left[1 - \frac{U_{i(t+k)}}{100} \right]}{\left[1 + \frac{\gamma_t}{100} \right]^k},$$

where

P_{it} is the present value of future lifetime income stream for a worker in the i th occupation in the t th year ($t=1917, 1918, \dots, 1962$),

$\hat{W}_{i(t+k)}$ is the annual wage rate in the i th occupation in the k th year ahead of the t th year,

$U_{i(t+k)}$ is the annual unemployment rate in the i th occupation in the k th year ahead of the t th year,

² Ideally, another component analogous to unemployment rate in the nonfarm occupation should have been taken into account. This component is the probability of survival of an individual at each of the future years. This probability was not taken into account, because probability of survival of an individual on the average is much the same in the farm and non-farm sectors.

³ The worker is assumed to be gainfully employed until death.

n_i^* is the life expectancy for a worker of specified age and is equal to $n_{1,i}$ for a 45-year-old worker and $n_{2,i}$ for a 25-year-old worker, and γ_t is the rate of interest in the t th year.

Regression model

The number of farm operators by age-group for 1970 is projected by using ratios of present value of future income streams in farming to that in non-farm occupations. The two farm operator supply models used are

$$(1) \quad \left(\frac{F_{it}}{S_{it}} \right) = a_i + b_i Z_{i,t}^k + u_{it}$$

and

$$(2) \quad \log \left(\frac{F_{it}}{S_{it}} \right) = \alpha_i + \beta_i \log Z_{i,t}^k + v_{it},$$

where F_{it} is the number of farm operators in the i th age-group in the t th agricultural census year, and S_{it} is the number of surviving rural farm males in the i th age-group. S_{it} was computed from the number of rural farm males in the previous decennial census adjusted for the numbers for deaths and intercensus enumeration errors by use of age-specific survival ratios. This shift variable was chosen because it approximates the number of potential farmers if there were no net migration. $Z_{i,t}^k$ is the ratio of the average present value of future income stream in the nonfarm occupation to that in farming during the ten-year interval prior to the t th agricultural census year for a worker of age i . For example, $Z_{i,t}^k$ in 1930 is the ratio of average present value during the period 1920–1929 in a nonfarm occupation, k , to that in farming for a worker of age i ; u_{it} and v_{it} are random errors. The observations of the dependent and independent variables are for the census years 1930, 1940, 1950, and 1960.

Sources and Type of Data Used

Basic data

The data used for estimating the present values of future income streams are mainly from published sources. Life expectancies for a white male worker at ages 25 and 45 were used [22, p. 4]. The annual average interest rate charged for farm mortgage loans was used for discounting the future income stream. The interest rate data for 1917–1940 are from published reports of the Bureau of Agricultural Economics [21]; the data for 1941–1957 are from Hesser [6]. The interest rates for 1960 to 1962 were interpolated by the method used by Hesser. While some other series, such as the rate on short-term notes, would have given different and perhaps less stable results, the farm mortgage rate seemed preferable on the *a priori* ground

that it applies to long-term investments adjusted for the uncertainties of both unemployment and death.

Annual wages, computed on the assumption that workers are fully employed through the year, were used for all five occupations. Farm wage rate data are from the agricultural statistics published by the U. S. Department of Agriculture [20]. Annual wages per worker in construction were computed on the basis of indices of union wages and hours, published by the Bureau of Labor Statistics [23]. Annual wages in other occupations, such as manufacturing, laundries, and retail trade, were also computed from the employment and earnings data published by the Bureau of Labor Statistics [25]. Wage rate data were not available for laundries before 1934 or for retail trade before 1939. Scatter diagrams showed a linear positive relationship between the annual earnings of workers in retail trade and laundries on the one hand, and the annual earnings of workers in building trades on the other, for the periods 1939–1951 and 1934–1947, respectively. Regressions of the form $Y = a + bX$ were fitted for data for these time periods. In this regression, Y is the annual wage in retail trade in one case and in laundries in the other case, and X is the annual wage in building trades. Annual wages in retail trade and in laundries were estimated from these regressions for the periods from which data were not available.

Published unemployment rates in the nonfarm occupations chosen were not available for the years before 1948 [24]. Scatter diagrams showed a linear positive relationship between unemployment rate in each nonfarm occupation used and the percentage of unemployed to nonfarm employees during the period 1948–1960. Thus, regression equations were estimated, with the percentage of unemployed to nonfarm employees as the independent variable. From these estimated regression equations, the unemployment rate in each chosen nonfarm occupation was estimated for the period 1917–1948, with the percentage of unemployed to nonfarm employees (which is available for the period 1917–1960) used as the independent variable.

Future income streams and unemployment rates

In this study, estimates of “actual” annual wage and unemployment rates for the future are a linear function of current and past rates with a set of constant weights. The regression models used for determining the future averages are as follows:

$$X_{p,t} = a_0^p + b_0^p X_t + b_1^p X_{t-1} + \cdots + b_k^p X_{t-k} + e^p$$

where

$$X_{p,t} = \frac{1}{p} \sum_{i=1}^p X_{t+i} \quad \begin{array}{l} p = 1, 2, \dots, 9 \\ t = 1917, 1918, \dots, 1962 \end{array}$$

and $a_0^p, b_0^p, b_1^p, \dots, b_k^p$ are constant weights in the p th equation for

all t . The variable X is used for unemployment as well as for wage rate; p , the subscript on the left-hand side and superscript on the right-hand side, indicates the number of the regression equation. X_p is the average of p future observations. In all the regression equations, in the cases of both annual wage rates and unemployment rates, the lag k was determined to be 1, because the regression coefficients of X_{t-k} where $K \geq 2$ were not significantly different from zero even at the 10-percent level. Hence, all the regression equations were fitted with only two independent variables, X_t and X_{t-1} . The maximum value for P was determined to be 9 in all occupations, because, in the case of the unemployment rate, \bar{R}^2 in the estimated regression equations beyond the ninth was lower than 0.13. Although \bar{R}^2 in the case of the annual wage rate was as high as 0.80 beyond the ninth regression equation in all occupations, the maximum value for P was also taken as 9 for the sake of uniformity as well as for reducing computations. In other words, there were nine regression equations for the unemployment rate and nine for the annual wage rate. The estimated unemployment rates and annual wage rates for future individual years X_{t+p} (where $p=1, 2, 3, \dots, 9$) up to the ninth year ahead of the t th year were derived as follows:

$$\hat{X}_{t+p} = p\hat{X}_{p,t} - (p-1)\hat{X}_{p-1,t} \quad (p = 1, 2, \dots, 9).$$

For unemployment rates beyond the ninth year, the estimate of the average for the next nine years was used instead of estimates for individual years.⁴ The same procedure was carried through for all years in the period 1917-1961. For 1962, the average unemployment rate for the preceding 15 years was used for expected unemployment rates beyond the ninth year ahead. The procedure adopted for the unemployment rate was also used to estimate the annual wage through the ninth year ahead.

Since there was a trend in the annual wage rate series, the following method was used to estimate the increments in future annual wages beyond the ninth year: Two life expectancies (approximately 26 and 44 years) were used for estimating future long-run average wage rates. These were average life expectancies for 45- and 25-year-old workers, respectively, during the period 1917-1962. The method was essentially designed to estimate the average increments in the annual wage from the ninth to the twenty-sixth year and from the twenty-seventh to the forty-fourth year ahead of the t th year. These two increments were used to estimate the annual wage per worker from the tenth year to the $(n_{1,t}-1)$ th year ahead ($n_{1,t}$ being the life expectancy of a 45-year-old worker in the t th year) and from the

⁴ First, we assumed that unemployment rates beyond the tenth year are the average of the preceding nine years. Second, we assumed that the adjustment of the annual wage beyond the tenth year, using an average unemployment rate in the first nine years, would not differ much from the adjustment of the annual wage using the unemployment rates for individual years. Third, we assumed that average unemployment rates for the years beyond the ninth year were the same as for the first nine years.

n th year to the $(n_{2,t}-1)$ th year ahead ($n_{2,t}$ being the life expectancy of a 25-year-old worker in the t th year. The procedure used to estimate these two increments for each year in the period 1917–1962 is as follows:

First, the two regression equations given below were fitted to the data⁵ for the period 1917–2007:

$$\text{and} \quad W_{26,t} = f_1(W_t, W_{t-1}, \dots, W_{t-k})$$

$$W_{44,t} = f_2(W_t, W_{t-1}, \dots, W_{t-k}),$$

$$\text{where} \quad W_{26,t} = \frac{1}{26} \sum_{k=1}^{26} W_{t+k} \quad \text{and} \quad W_{44,t} = \frac{1}{44} \sum_{k=1}^{44} W_{t+k}.$$

In both regression equations in each occupation, the lag k was determined to be one because the regression coefficients were not significantly different from zero at the 10-percent level.

Next, the increments in future wages were estimated from the foregoing regression equations⁶:

$$\hat{\Delta}_{1,t} = \frac{2}{17} \left[\frac{1}{17} (26\hat{W}_{26,t} - 9\hat{W}_{9,t}) - \hat{W}_{t+9} \right]$$

and

$$\hat{\Delta}_{2,t} = \frac{1}{9} \left[\frac{1}{18} (44\hat{W}_{44,t} - 26\hat{W}_{26,t}) - \hat{W}_{t+9} - 17\hat{\Delta}_{1,t} \right],$$

⁵ Estimation of present values in this study required estimation of the income stream in the future through the remaining lifetime of a worker. Estimation of the future income stream for a 25-year-old worker in the year 1962, for example, required data up to the year 2007, because the life expectancy of a 25-year-old worker in the year 1962 was 45 years. Data on expected annual wages from 1963 to 2007 were also required to obtain more degrees of freedom in fitting the regression equations for estimating the annual wage in the longer period, that is, up to 45 years in the future. Hence, we decided to estimate annual wages from 1963 to 2007. The projection of annual wage in the respective occupations was the dependent variable, and time was the independent variable. In the absence of information on future economic activity, projection of past trends into the future seems reasonable. Regression lines were fitted for the time period 1950–1962. The reason for the selection of the method and the time period was that the annual wage per worker in all occupations considered has steeply increased and had a high linear correlation with the time variable from 1950 to 1962. Regression equations and projected series on annual wage for the period 1963–2007 can be found in the complete study [3].

⁶ Since there was a trend in the annual wage per worker, the difference between the estimate of the future average annual wage from the tenth to the twenty-sixth year ahead, $1/17 (26\hat{W}_{26} - 9\hat{W}_9)$, and the estimate of the annual wage in the ninth year ahead, (\hat{W}_{t+9}) , is $8\frac{1}{2}$ times the average increment ($\hat{\Delta}_1$) in the annual wage from the tenth year to the twenty-sixth year ahead. The reason for this is that the estimate of the average of the values for the years between the ninth and the twenty-sixth year ahead lies in the middle of the 17-year period. Being an average between the forty-fourth and the twenty-sixth year ahead, $1/18 (44\hat{W}_{44} - 26\hat{W}_{26})$ does represent a point in the middle of the 18-year period. Hence, $(\hat{W}_{t+9} + 17\hat{\Delta}_1)$, the estimate of the future annual wage for the twenty-sixth year ahead, is subtracted from $1/18 (44\hat{W}_{44} - 26\hat{W}_{26})$ to obtain the difference, $9\hat{\Delta}_2$, or nine times the average increment in that period, that is, from the twenty-sixth to the forty-fourth year ahead.

where

$\hat{\Delta}_{1,t}$ is the estimate of increments in annual wage from the tenth year through the twenty-sixth year ahead, and

$\hat{\Delta}_{2,t}$ is the estimate of increments in the annual wage from the twenty-sixth year through the forty-fourth year ahead.

The estimated annual wages and unemployment rates in each occupation for each year in the future from the t th year were then used to estimate present values of income in each of the five occupations.

Present Values of Future Income Stream by Occupation

The present values in the five occupations are given in Tables 1 and 2. The estimated present values are consistent with major economic and political events.⁷ The impact of the end of World War I is reflected by the drop in present values in all occupations for both 25-year-old and 45-year-old workers in 1912. The onset of the depression in the early 1930's was followed by low present values. In the postdepression period and the beginning of World War II, present values increased in almost all occupations for both 25- and 45-year-old workers.⁸

The entry of the United States into World War II in 1941 had a tremendous impact on the future income stream. Present values increased in almost all occupations for both 25- and 45-year-old workers in 1941. In manufacturing, present value jumped from \$45,000 in 1940 to \$53,000 in 1941 for a 25-year-old worker. In construction, it increased from \$54,000 to \$62,000. For a 45-year-old worker, present value increased from \$29,000 in 1940 to \$36,000 in 1941 in manufacturing, and from \$35,000 to \$40,000 in construction.

The Korean War also seems to have caused increases in present values. The present value for a 25-year-old worker increased from \$47,000 in 1950 to \$55,000 in 1951 in farming; from \$90,000 to \$97,000 in manufacturing; from \$104,000 to \$114,000 in construction; from \$49,000 to \$53,000 in laundries; and from \$52,000 to \$68,000 in retail trade. For a 45-year-old worker, it increased from \$31,000 in 1950 to \$39,000 in 1951 in farming; from \$61,000 to \$66,000 in manufacturing; from \$68,000 to \$76,000 in construction; from \$35,000 to \$37,000 in laundries; and from \$36,000 to \$47,000 in retail trade.

The end of the Korean War caused decreases in present values. For a

⁷ The present values in each occupation from 1917 to 1962 were not corrected for price changes, because ratios rather than absolute figures were used in the regression analysis. On the assumption that inflation and depression have the same effect on both farm and nonfarm sectors, the ratios were not corrected for price changes.

⁸ The age-earnings profile used in computing present values for persons of two different ages was not made, because data on average wages for workers in specific age groups in an occupation are not available. Average wages per worker in an occupation and differences in life expectancies were used instead.

Table 1. Present value of future income stream for a 25-year-old worker in various occupations in the United States, 1917-1962

Year	Farming	Manufacturing	Construction	Laundries	Retail trade
	<i>..... current dollars, in thousands</i>				
1917	19	27	27	13	18
1918	21	33	32	15	19
1919	22	34	32	15	20
1920	24	35	42	20	26
1921	12	25	28	18	21
1922	17	31	33	18	22
1923	20	37	41	20	25
1924	19	33	39	21	26
1925	19	36	42	22	27
1926	20	36	46	24	29
1927	20	35	44	24	28
1928	20	35	43	24	28
1929	20	36	44	24	27
1930	18	30	39	23	27
1931	14	26	34	22	26
1932	13	22	25	19	21
1933	15	27	33	20	24
1934	19	34	41	23	28
1935	19	34	39	23	27
1936	21	39	47	26	31
1937	23	43	52	27	34
1938	21	36	47	26	33
1939	22	42	51	28	33
1940	23	45	54	29	35
1941	26	53	62	30	37
1942	32	66	71	31	40
1943	38	73	68	36	42
1944	40	74	68	39	45
1945	42	71	72	41	47
1946	44	70	83	45	54
1947	48	83	98	49	61
1948	50	86	105	50	62
1949	48	81	96	48	61
1950	47	90	104	49	52
1951	55	97	115	53	68
1952	43	97	114	51	67
1953	53	100	119	52	69
1954	51	95	116	52	69
1955	53	108	128	54	74
1956	56	108	134	55	75
1957	56	106	131	54	74
1958	55	101	129	54	73
1959	57	112	142	55	75
1960	56	107	139	55	74
1961	54	105	139	54	73
1962	56	118	156	57	78

Table 2. Present value of future income stream for a 45-year-old worker in five occupations in the United States, 1917-1962

Year	Farming	Manufacturing	Construction	Laundries	Retail trade
	<i>current dollars, in thousands</i>				
1917	13	19	18	9	12
1918	15	23	22	10	13
1919	16	24	22	11	14
1920	18	26	32	16	20
1921	8	18	20	14	16
1922	12	22	22	13	16
1923	14	26	28	15	18
1924	13	23	27	15	19
1925	13	25	29	16	19
1926	14	25	32	18	21
1927	13	24	30	18	20
1928	13	24	29	17	20
1929	14	25	29	17	20
1930	12	20	27	17	20
1931	9	18	23	17	19
1932	8	14	15	13	14
1933	9	17	20	14	16
1934	12	21	25	16	18
1935	12	22	24	16	18
1936	13	25	30	18	20
1937	13	29	34	19	23
1938	13	23	31	18	23
1939	13	28	32	19	22
1940	14	29	35	20	24
1941	17	36	40	21	25
1942	21	45	46	23	27
1943	26	50	42	25	28
1944	28	50	42	28	30
1945	29	46	45	29	32
1946	30	46	55	31	37
1947	32	55	66	34	41
1948	35	58	70	35	42
1949	33	54	62	34	42
1950	31	61	68	35	36
1951	39	66	76	37	47
1952	38	67	76	37	47
1953	38	69	81	38	49
1954	36	65	78	37	48
1955	38	76	85	38	52
1956	40	76	91	40	53
1957	42	77	93	40	54
1958	41	74	92	41	54
1959	43	84	102	42	56
1960	43	80	101	42	56
1961	42	80	102	42	55
1962	44	89	113	44	59

25-year-old worker, present value decreased from \$53,000 in 1953 to \$51,000 in 1954 in farming; from \$99,000 to \$95,000 in manufacturing; from \$119,000 to \$116,000 in construction. For a 45-year-old worker, it decreased from \$38,000 in 1953 to \$36,000 in 1954 in farming; from \$69,000 to \$65,000 in manufacturing; from \$81,000 to \$78,000 in construction; from \$38,000 to \$37,000 in laundries; and from \$49,000 to \$48,000 in retail trade. After 1954, present values in all occupations increased through 1962, although there were slight fluctuations within the period. Much of the trend in the values of workers in the five different occupations could be eliminated by expressing the values in terms of constant dollars. For some purposes this should be done. However, for the purposes at hand, little would be gained by deflation, because only ratios between different pairs of series are used in projecting age distribution.

Regression Results for Supply Model

The farm operator supply model was estimated in both linear and logarithmic form (one for each nonfarm occupation) for each age-group of farm operators. However, all estimated regression equations in the linear form are omitted, because they explain variation in the dependent variable less than do those in the logarithmic form. Those in the logarithmic form in which the regression coefficients are not significantly different from zero are also omitted from this article.

The only equations with significant coefficients for the 15- to 24-year and the 25- to 34-year age-groups were those for manufacturing, the representative of the group of industries which competes most rigorously with agriculture for young men. Older farm workers, on the other hand, are largely disqualified from entering manufacturing and must be satisfied with jobs in such areas as the service industries and local government. The only significant equations for the three older age-groups involve laundries, which represent the service and similarly paid industries. It should be noted that one and only one of the eight equations for each age-group is significant (Table 3).

For the first two age-groups, the sign of the regression coefficient is negative, a fact which indicates that as the ratio of present value in manufacturing to that in farming increases over the course of time, the number of farm operators will decrease, given the number of surviving rural males (Table 3). This result is due to the fact that young people find urban jobs so attractive that more and more of them are leaving farming and fewer are entering. In the remaining age-groups, the regression coefficient is positive. One possible explanation is that the number of older farmers and the ratio of expected present value for a 45-year-old worker in a laundry to that for a worker of the same age in retail trade have been declining over the course of time. Since both these variables have a high negative correlation with

Table 3. Estimated supply models for farm operators in each age-group^a

Age group	Regression	Degrees of freedom	R ²
15-24	$\log (F_t/S_t) = 3.7647 - 19.3192 \log Z_{25,t}^m$ (1.0863) (4.1768)	2	0.87
25-34	$\log (F_t/S_t) = 1.4159 - 7.4541 \log Z_{25,t}^m$ (0.7301) (2.8071)	2	0.67
35-44	$\log (F_t/S_t) = -0.1941 + 0.5247 \log Z_{25,t}^m$ (0.0182) (0.1998)	2	0.66
45-54	$\log (F_t/S_t) = -0.1123 + 0.4627 \log Z_{45,t}^l$ (0.0176) (0.1935)	2	0.61
55-64	$\log (F_t/S_t) = -0.1123 + 0.6032 \log Z_{45,t}^l$ (0.0134) (0.1479)	2	0.84
65 and older	$\log (F_t/S_t) = -0.2549 + 0.7979 \log Z_{45,t}^l$ (0.0167) (0.1838)	2	0.86

^a $Z_{25,t}^m$ is the ratio of the present value of future income stream in manufacturing to that in farming for a 25-year-old worker.

$Z_{45,t}^l$ is the ratio of the present value of future income stream in laundries to that in farming for a 45-year-old worker.

Figures in parentheses are the standard errors of the regression coefficients.

time, they have a positive correlation with each other. Most of these regression coefficients are significantly different from zero at the 5-percent level.

Projection of Number of Farm Operators

The number of farm operators in each age-group is projected for 1970 on the basis of regression results and projected present values for 1960-1970. The total number of farm operators is obtained by adding the projected numbers in each age-group. The number of farm operators in each age-group is estimated as follows: The average present value in each occupation during the period 1960-1970 is estimated on the basis of projected present value in farming and in nonfarm occupations. This ratio is then used for estimating the ratio of the number of farm operators to the number of surviving rural farm males in each age-group. This estimated ratio (of farm operators to surviving rural farm males in an age-group) is then multiplied by the estimated number of surviving rural farm males in the corresponding age-group to obtain the estimated number of farm operators for 1970.

Table 4 gives the number of farm operators in each age-group in 1960 and in 1965 and projected numbers for 1970 from this study and three

Table 4. Number of farm operators in the United States by age-group for 1960 and 1965, and estimates for 1970, using 1960 census definition

	Age-group						
	Total	< 25	25-34	35-44	45-54	55-64	65+
	<i>thousands</i>						
Census, 1960	3,701	62	407	812	988	809	623
Census, 1965 ^a	3,158	53	309	654	852	742	548
Estimates for 1970 by							
Bishop and Tolley [2]	2,654	56	269	401	676	692	557
Fox [5]	2,500	43	235	382	645	662	531
Johnston [12]	2,593	50	254	398	663	680	546
This study [3]	2,616	30	222	415	688	701	556

^a Data obtained by private communication from Ray Hurley, chief of the Agricultural Division, Bureau of the Census.

previous studies. The projection for 1965 could not be made because the cohort length is ten years. The total number of farm operators estimated in this study is 2,616,000, which is very close to that estimated by previous studies.

According to the 1965 census, there were 53,000 farm operators between 15 and 24 years of age. The number of farm operators projected in this study is 30,000; projections by Bishop and Tolley [2], Fox [5], and Johnston [12] are 56,000, 43,000, and 50,000, respectively. The estimates made in this study are lower for the two youngest age-groups and higher for older age-groups than estimates in the previous studies.

Conclusions

Present values of future income streams, apart from fluctuations caused by major political or economic events, showed phenomenal increases from 1917 to 1962, which can be attributed to (a) increases in the price level and (b) increased marginal productivity of workers, resulting from higher levels of education, reduced use of labor, and more knowledge. The ratio of present value in manufacturing to that in farming for a 25-year-old worker was used in regression analysis as an indicator of the acquisition cost of labor for the agricultural economy. The ratio of present value in a service industry, laundries, to that in farming for a 45-year-old worker was used as an indicator of the salvage value of older farm operators.

The total number of operators projected for 1970 in this study and in previous studies do not differ much from one another. However, the age distribution of farm operators appears quite different. The projected number of young farm operators for 1970 is generally lower in this study than in previous studies, and the number of older farmers is generally higher. According to the projections in this study, there will be a reduction of more

than half a million farm operators between 1965 and 1970. The projected number of farm operators in each age-group for 1970 indicates that the trend toward a higher average age of farm operators will probably not be reversed. This is clearly shown by the very small number of farm operators in the age-group 15-24. This trend might be reversed in the future if the ratio of present values of future income streams in the nonfarm sector to those in the farm sector became more favorable for farming.

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On Benefit-Cost Analysis of Investment in Schooling in Rural Farm Areas*

MICHA GISSER

The effect of additional schooling on economic productivity of human agents working on farms is estimated. The cost of schooling is measured by estimating the direct cost of schooling and income foregone while attending school. A model of the farm labor market is constructed. Schooling appears as a predetermined variable in the supply and demand functions of the model. The empirical results of fitting cross-sectional data to a reduced equation in which the farm wage rate is a dependent variable are utilized in order to obtain an estimate of the pecuniary benefit of schooling. The benefit-cost ratio of schooling in farm areas is computed to be 2.37. This result suggests that comprehensive rural development in the less-developed countries should strike a balance between investment in schooling and tangible capital.

EVIDENCE indicates that raising the level of schooling in rural farm areas will stimulate farm out-migration and that this will more than offset the effect of higher productivity on farms, thus increasing farm income significantly [3].

The focus of this article is on the effect of additional schooling on economic productivity of human agents working on farms. Because of the price inelasticity of demand for farm produce, the effect of additional schooling on stimulating farm out-migration outweighs its effect on the productivity of farm labor. This problem has been the subject of another article [3]. The purpose of this article is, first, to present a general method of estimating the benefit-cost ratio of investment in schooling and, second, to draw some important inferences concerning the development of farm areas in underdeveloped countries.

In the United States, a substantial proportion of schooling is a public service. Thus, the government provides schooling at the grammar and high-school level free, and at higher levels at a price lower than the marginal cost of schooling. The market price is almost entirely absent as a signaling device to indicate whether too much money or too little money has been invested in schooling. Accordingly, it is tempting to estimate the benefit-cost ratio of schooling. Such an estimate may serve as a guideline for formulating the government's policy toward investing in schooling. Moreover, a high benefit-cost ratio of investment in schooling is a criterion used by important institutions such as the World Bank, to consider

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applications for loans to finance the schooling systems in developing countries.

More generally, economists should be challenged by estimating the benefit-cost ratio of public services such as schooling, national parks, and government-supported research. A comparison of the benefit-cost ratio of schooling with that of the Grand Canyon may result in a substantial improvement in the decision process through which a government's budget is allocated among the various competing public goals.

The benefit-cost ratio of investment in schooling in rural farm areas is based on estimates of the cost of schooling and the monetary benefit of schooling.

The Cost of Schooling

The direct cost of schooling is the actual cost of services rendered by schools; the indirect cost of schooling is income foregone by students while they are attending school. Schooling has become such an important industry in the modern economy that it is of utmost importance to reach some consensus on the procedure of calculating its benefit-cost ratio. Let us start with estimating the direct cost of schooling.

In 1958, gross current expenditures on educational services rendered by public elementary and secondary schools in the United States amounted to \$13,569 million [17, p. 18]. *Gross current expenditures* is composed of such items as administration, instruction, plant operation, maintenance, and capital outlay, of which instruction accounts for about half. Subtracting \$2,853 million capital outlay [17, p. 18] yields net current expenditures in the amount of \$10,717 million.

The original value of physical assets of public elementary and secondary schools amounted to about \$24,000 million [16, p. 25].¹ In line with Robert Rude's study [4], T. W. Schultz advised me to use no depreciation or obsolescence on land, to assume that the economic lifetime of buildings is 33 years and that of equipment 10 years, and to use an implicit rate of interest of 5 percent. He also advised me to assume that the distribution of physical assets was 20 percent land, 72 percent buildings, and 8 percent equipment [2, p. 25], and I estimated the cost of capital on the basis of this assumption (Table 1). The figure of \$24,883 million is obtained by adjusting \$24,000 million to current-year value.

Adding \$10,717 million current expenditures to \$2,248 million capital cost amounts to \$12,965 million direct cost of public schooling. Enrollment in 1958 reached 25,669,000 pupils in public elementary schools and 7,860,000 in public secondary schools [17, p. 18]. The ratio of expendi-

¹ The amount of \$24,000 million is a rough figure obtained by adjusting the figure of 1955-56 for depreciation and capital outlay during 1957-58.

Table 1. The annual cost of capital invested in public elementary and secondary schools in the United States, 1958

Item	Current value of physical assets	Economic lifetime of assets	Capital return coefficient ^a with interest rate at 5 percent (expressed as decimal)	Cost of capital (col.1 × col. 3)
	<i>millions</i>	<i>years</i>		<i>millions</i>
Buildings	\$24,883	33	0.062	\$1,543
Land	6,912	—	0.050	346
Equipment	2,765	10	0.130	359
Total	\$34,560			\$2,248

^a Capital return coefficient is $i(1+i)^n/[(1+i)^n-1]$, where i denotes the rate of interest and n the number of years. This coefficient may be written as $i/[(1+i)^n-1]+i$ [1, p. 278].

tures per pupil in secondary schools to expenditures per pupil in elementary schools was computed to be 1.36 [2, p. 26]; thus, the annual direct cost per pupil in 1958 was estimated at \$357 for elementary schools and \$485 for secondary schools. However, because the average current cost of schooling is lower in rural farm areas than in the United States in general, the figures of \$357 and \$485 are upward-biased estimates for rural farm areas. In 1955-56, current expenditures per pupil in rural farm areas amounted to 85 percent of that in the United States as a whole [2, p. 29].

In order to calculate the total cost of schooling, one has to add the indirect to the direct costs. The indirect cost of schooling was defined earlier as income foregone while attending school. Income foregone while attending high school is estimated as follows: Average farm wage rate per day in 1958 amounted to \$6.00. To adjust it for males 14-17 years of age, one multiplies \$6.00 by 0.57 [5], obtaining an estimate of \$3.42 per day. Income foregone must be adjusted not only to age but also to the fact that some pupils in secondary schools participate in the labor force by working part time. The adjustment is carried out in Table 2.

Thus, 0.59 times \$3.42 (the daily farm wage rate for males 14-17 years of age) yields an estimate of \$2.02 income foregone per day. Multiplying it by 178 days, which was the average length of the school term, gives an estimate of \$360 foregone per year. This is less than my estimate elsewhere of \$1,500 [3]. But in making that estimate, I was interested in the gross estimate of income foregone while attending school. This was necessary for showing that the *upper limit* of the cost of a program in which the government would pay both the income foregone and the direct cost of high schools in rural farm areas would not exceed \$2 billion. One of the purposes of this article is to demonstrate a precise method of estimating the cost of schooling. In the interest of precision, one must take ac-

Table 2. The ratio of average number of hours foregone per male enrolled in school to average number of hours worked by male members of the labor force, 1960

Enrollment	Labor force participation rate (males)	Average hours worked per week (males)	Average hours worked per person (col. 1 \times col. 2)	Ratio
Not enrolled	<i>percent</i> 75.9	<i>hours</i> 42	<i>hours</i> 31.9	$\frac{24.8}{42.0} = 0.59$
Enrolled	26.2	27	$\frac{7.1}{24.8}$	

Source: my Ph.D. thesis [2, p. 33].

count of the fact that a student who attends school 180 days a year still has a theoretical possibility of working 185 days without infringing on school time. Table 2 makes an adjustment for this possibility.²

In summary, the annual cost of schooling at the secondary level is obtained by adding \$360 income foregone to \$485 direct cost of schooling for a total of \$845.

Returns to Schooling

Farm wages vary from state to state. In what follows we shall see that the level of schooling is an important independent variable which contributes substantially to the explanation of farm wage variation. The following model assumes that agricultural production in each state can be reasonably represented by an aggregate production function. Furthermore, the parameters in the production function of each state may be regarded as identical. The aggregate demand for labor is obtained by differentiating the aggregate production function with respect to labor input and multiplying the resulting derivative by the price of farm product. The model also assumes that the parameters of the supply function of farm labor in each state may be regarded as identical. The equation representing demand for labor is

$$(1) \quad W = a_1 + a_2L + a_3C + a_4S - a_5R.$$

The equation representing supply of labor is

$$(2) \quad W = b_1 + b_2L + b_3W + b_4S + b_5R.$$

² A reviewer of the manuscript for this article pointed out that Table 2 does not make a full adjustment for this possibility. I agree; but until better data are available, no further adjustment can be made.

If the variables are in logarithms, then the coefficients become constant elasticities. In this model, W stands for farm wages, L is labor input per farm, C stands for capital per farm, \bar{W} is alternative (nonfarm) wages, S is the level of schooling of males in rural farm areas, and R is the ratio of whites to total farm employees. The introduction of the alternative wages denoted by \bar{W} is required because it is possible that farm workers with more schooling are more alert to alternative (nonfarm) jobs which are available elsewhere in the economy. \bar{W} is predetermined. In this model, C is also predetermined. This is true because in the short run the process of capital accumulation precedes the act of demanding labor in the market. In the long run the process of capital accumulation reflects to a limited degree the situation in the labor market. However, this point cannot be pushed too far because of the imperfections prevailing in the markets for farm capital. In this model, schooling, S , and racial mix, R , are also predetermined. This stems from the accepted notion that education and racial mix are mainly functions of sociohistorical factors rather than economic factors.

Accordingly, the farm wage rate, W , and farm labor, L , are the only variables determined by this model. Thus, the model is just identified, and its two reduced forms are

$$(3) \quad W = A_1 + A_2C + A_3\bar{W} + A_4S + A_5R$$

and

$$(4) \quad L = B_1 + B_2C + B_3\bar{W} + B_4S + B_5R.$$

Equation (3) is the relation with which returns to schooling in rural farm areas are estimated. In this article, the "farm problem" is assumed away. The effect of more schooling on the farm problem was the subject of another article [3]. Since the farm problem is not the subject of this article, equation (3) is sufficient for determining the effect of schooling on farm wages. In order to estimate the regression coefficients of equation (3), I used cross-sectional pooled data by states for 1950 and 1960.³

The results of this study would be more valuable if it could be shown that, in general, variations among states did not change significantly over the period 1950-1960. Moreover, cross-section stability through the course of time would justify using a pool of 1950 and 1960. Indeed, the correlation coefficients between the same variables in 1950 and 1960 were in the order of magnitude of 0.95. The results of fitting equation (3) to the data are shown in Table 3. Notice that the results are significantly improved when a logarithmic rather than the linear form is used. Accord-

³ See the Appendix.

Table 3. Empirical results of fitting equation (3) to the data: pool of 1950 and 1960^a

Equations	Dummy variables	Intercept	Capital	Alternative wages	Racial mix	Schooling	R ²
Linear with time variable	-13.49 (13.49)	-878 (214)	0.030 (0.009)	9.706 (3.882)	0.570 (0.285)	240 (42)	0.832
Linear without time variable		-830 (268)	0.030 (0.009)	6.503 (2.099)	2.063 (2.063)	237 (42)	0.829
Logarithmic with time variable	-0.010 (0.014)	1.28 (0.13)	0.15 (0.03)	0.28 (0.13)	0.16 (0.08)	0.65 (0.16)	0.878
Logarithmic without time variable		1.35 (0.10)	0.15 (0.03)	0.10 (0.07)	0.20 (0.07)	0.65 (0.17)	0.879

^a Values in parentheses are standard errors.

ingly, equation (3) in its logarithmic form is used for estimating the benefit-cost ratio of investing in schooling. (The dummy variables in Table 3 stand for 1950 and 1960 respectively.) Table 3 shows that the regression coefficient of the dummy variable from the logarithmic form does not change significantly the regression coefficients of the explaining variables.

There is an advantage to using cross-sectional data in which each state is one observation; another approach would be to use cross-sectional data based on a random sample of rural farm people, in which each person is one observation. In the first case, the level of schooling at the state level is schooling per se; in the second case, the level of schooling of the individual person is probably a proxy for talent. Accordingly, although a study of schooling based on cross-sectional data by states may lead to strong policy recommendations, the same study based on cross-sectional data by persons may lead to vague conclusions.

The value of the estimated coefficient of schooling in Table 3 is 0.65. This indicates that, on the average, raising the level of schooling of one individual in rural farm areas 10 percent will lead to increasing his wage rate 6.5 percent.

This result does not indicate that the effect will be the same if the level of schooling of all farm people in the United States is raised 10 percent. More schooling for all farm employees will increase total agricultural production and accordingly lead to price reduction. It is possible, however, that the decrease in the price of agricultural output will be more than offset by farm out-migration resulting from more schooling [3].

What is the possibility that schooling is picking up some of the association that might in another model be picked up by capital per farm? I doubt that we can design a test which will give us the answer to that question. The correlation matrix in Table 4 shows that the correlation

coefficient between schooling and farm wages amounts to 0.86, which is higher than any of the other correlation coefficients. The correlation between farm wages and capital per farm is 0.73; between schooling and capital it is only 0.62. It is possible to assume that schooling is a vehicle for larger scale as well as for a higher degree of technological sophistication on farms. Since larger scales and a higher degree of sophistication require more capital, capital per farm is positively correlated with schooling. Although this study points in this direction, it does not prove the proposition.

The correlation coefficient between schooling and racial mixture is 0.72. This reflects the known fact that white employees have a higher level of schooling. The omission of this variable from the regression would bias upwards the regression coefficient of schooling. The regression coefficient of racial mixture, R , is 0.16. It means that raising the proportion of whites among farm employees by 10 percent will result in a 1.5 percent increase in the average farm wage rate. The regression is blind: it is not capable of telling us whether this situation is due to discrimination or to other reasons.

The Benefit-Cost Ratio of Schooling

Consider now a farm boy who wants to make a rational decision concerning investment in one year of high school.

For the sake of presenting the method, let us assume that the individual has to bear the direct cost of schooling in addition to the indirect cost of income foregone while he is attending high school. Thus, the annual current cost of schooling is expected to be \$845. On the average, this amounts to increasing schooling 10 percent. Returns to more schooling at the secondary school level are estimated as follows: Average farm wage rate per day in 1958 amounted to \$6.00. Assuming 300 working days per year yields an annual income of \$1,800. Increasing years of school completed by farm laborers from 10 to 11 years is equivalent to a 10-percent increase in the level of schooling. Applying the wage-schooling elasticity, which is estimated at 0.65, indicates that, roughly, raising the level of schooling 10 percent will result in increasing the average wage rate of the individual farm-worker 6.5 percent.

Table 4. Simple correlations of the variables used in equation (3)

	W	C	\bar{W}	R	S
Farm wages (W)					
Capital (C)	0.73				
Alternative wages (\bar{W})	0.76	0.68			
Racial mix (R)	0.61	0.31	0.41		
Schooling (S)	0.86	0.62	0.66	0.72	

The average level of schooling in rural farm areas in 1960 was about eight years. Thus, it is possible that the real wage-schooling elasticity is lower than 0.65 when applied to a higher level of ten years of schooling, because marginal physical product of schooling may diminish toward the end of high school. The possibility of diminishing returns to schooling could not be tested. It seems safe to assume that even if there are diminishing returns they are offset by the fact that we are applying the rate of 6.5 percent to a fixed average farm income of \$1,800. But during the working lifetime of the individual, his average income is expected to rise as a result of more capital investment and technological changes. Taking 6.5 percent of \$1,800 yields an additional current income of \$117 per annum. Assuming, for simplicity, that the additional \$117 accrues at the end of each year, and that the working lifetime of the individual is 40 years, then the present value of future income accruing to one year of schooling at the high-school level amounts to $\$117 \times 17.159^4 = \$2,007$. Thus, the benefit-cost ratio of schooling is computed as follows: $\$2,007/\$834 = 2.37$. Accordingly, on the average it pays the individual farm-worker to acquire more schooling at the high-school level.

The schooling used for measuring labor productivity was actually acquired by the larger part of the population about the time of World War II. Since then, the quality of schooling has probably increased.

Some inadequacies may also arise in drawing inferences from an analysis at a high level of aggregation. But, as noted previously, the advantage of using states rather than individuals as observations is that, at the state level, the level of schooling is a reasonable measure of schooling per se, whereas schooling acquired by an individual may reflect other factors, such as diligence and talent. Moreover, this study is only one test among many which are attempting either to confirm or to reject the theory that schooling is an important factor contributing to productivity.

Conclusion

The most important inference that may be drawn from this study relates to underdeveloped countries. This study shows that more schooling affects favorably the process of agricultural production. It does not tell us whether schooling is a vehicle for a higher degree of technological sophistication, or a factor of production per se. In that respect, economics is in the same boat with medical sciences: the medical profession has determined that smoking is associated with lung cancer. But nobody knows why. In spite of the fact that we are dealing here with an "empty box," this study suggests that comprehensive rural development in underdevel-

⁴ $17.159 = \left(\frac{1}{1.05}\right)^1 + \left(\frac{1}{1.05}\right)^2 + \cdots + \left(\frac{1}{1.05}\right)^{40}$.

oped countries should strike a balance between investment in human capital and tangible capital. Finally, the findings of this article are reinforced by the fact that schooling has some important consumption value, which unfortunately is difficult to measure.

Appendix

The Data

Farm Wages, W: Annual average composite farm wage rates [6].

Capital, C: The rate of interest charged on farm capital, plus capital consumption and current expenditures, all divided by the number of farms [14, Chap. 1, Table 10; 15, Tables 1 and 6]. Estimates of the value of machinery and equipment were obtained from the U.S. Department of Agriculture, Farm Income Branch. The estimates of capital consumption and current expenditures are available in two series of state estimates [7 and 8].

Alternative Wages, \bar{W} : Average weekly earnings of production workers in manufacturing industries [12, Table 265; 13, Table 297].

Schooling, S: Median years of school completed by males 25 years of age and older in rural farm areas [9, Table 65 for each state; 11, Table 58 for each state].

Racial Mixture, R: The ratio of whites to total farmers, farm managers, laborers, and farm foremen [10, Table 77 for each state; 11, Table 58 for each state].

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An Evaluation of the Disincentive Effect Caused by P. L. 480 Shipments*

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Changes in foodgrain prices and domestic output caused by changing the quantity of U. S. Public Law 480 shipments to a hypothetical country show that both prices and output are highly sensitive to elasticities of supply and demand. But for many cases examined, changes in these shipments had relatively insignificant price-output effects and these could have been offset by a modest growth in population. Estimates of parameters for India indicate that a 20-percent increase in the quantity of foodgrain shipments between 1956-57 and 1961-62, other things being equal, would have decreased foodgrain prices 1.6 percent and domestic foodgrain output 0.4 percent. These disincentives may be outweighed by the effects on consumption, income distribution, and resource allocation, suggesting that, overall, the effects of P. L. 480 shipments are beneficial.

THERE has been a good deal of argument over adverse and positive effects of U. S. Public Law 480 shipments. Of particular concern to policy makers is the effect of shipments on prices and domestic output in recipient countries. Witt has concluded that "all indications are that this [disincentive effect] is one of the most critical problems for P. L. 480. It should, therefore, be given the highest priority" [14, p. 88]. Economists hold diverse views about these effects, including the following:

1. Because the domestic supply curve for foodgrains is highly price-inelastic or even negatively sloped, P. L. 480 shipments affect output only slightly even though they do cause prices to decrease [5, 10]. The result is a redistribution of income away from the agricultural sector.

2. By lowering prices for foodgrains, P. L. 480 decreases output as producers shift resources to the production of nonfood products. Although the composition of output changes, total farm production does not change because aggregate supply is very inelastic [1].

3. Although lower prices for foodgrains do not significantly affect short-run supply, they discourage private investment; lower private investment, in turn, diminishes long-run output. P. L. 480 shipments also allow governments to neglect public investment in the agricultural sector, and this neglect also hinders long-run output [4, 12].

Without subscribing to any of these arguments, I develop a conceptual framework in order to isolate and obtain probable bounds on the price-output effects. This is accomplished by comparing various combi-

* I appreciate the guidance of Dale E. Hathaway in conducting the research on which this article is based and the suggestions of Dupe Olatumbosun in preparing the final manuscript.

nations of possible supply and demand elasticities along with plausible values for other parameters in a hypothetical country. Although the framework coincides only partially with the actual situation in any particular country, this approach allows us to focus on the primary objective of this article: to evaluate the likely magnitudes of the disincentive effects.

If the *ceteris paribus* disincentive effects are small, say under 5 percent, they will be less crucial to policy makers than if they are on the order of 15 to 20 percent. But in any case, related economic effects must be included in a normative evaluation of P. L. 480 shipments. Consequently, the directly related effects on consumption levels, income distribution, and resource allocation are also examined. For concreteness in evaluating these related effects, I have selected estimates of parameters for India, although I recognize that this application is tentative and that extended investigation would be required to determine how well the Indian situation during the period studied agreed with the conceptual framework. The framework presumably would be inappropriate for India since 1964, when shortages developed, prices rose rapidly, and public procurement and distribution increased considerably.

Conceptual Framework

In order to isolate the price-output effects, it is necessary to abstract from factors which may operate concurrently with changes in P. L. 480 shipments. For example, the recipient country may use shipments to reduce serious price fluctuations, thus providing to producers a positive inducement which may exceed the negative effects of lower average prices [2, 10, 12]. I also abstract from the problems of imperfect product flows when, for example, shipments move into areas that are or can be largely separated economically from other producing or consuming regions. Here the localized effects would be to augment an inadequate food supply and, under severe conditions, to prevent famine.

In brief, we are considering shipments which move through the same distribution system as domestic supplies and influence prices in the same way as an equivalent amount of additional domestic output. Most sales for local currency and long-term dollar credit meet this requirement. Moreover, we assume that price disparities between areas represent only differences in transportation costs and are not due to government intervention in marketing and distribution. It is further assumed that shipments substitute readily in consumption for domestic foodgrains. This assumption implies that P. L. 480 food commodities, even though wheat may be the principal one, influence all foodgrains uniformly so that we are permitted to aggregate them into a single commodity. Changes in private and public foodgrain stocks are assumed to sum to zero during the period being considered so that total stocks remain constant and do not

affect equilibrium prices. Finally, in order to isolate the price-output effects, we assume that shifts in the supply curve due to past government investment programs just offset demand shifts arising from income growth so that stable prices would prevail in the absence of shipments. If our interest extended beyond estimating only the P. L. 480-induced effects, then this last assumption could easily be relaxed. Because population growth is so important in almost all recipient countries, it is included in the model.¹

Consider first the aggregate annual supply of foodgrains from domestic output (S) which will depend on, among other things, prices at the producer level (P) and government investment in food production (G): $S = S(P, G)$. We expect that at least some producers adjust production upward (downward) when prices increase (decrease).² The price variable is defined in real price terms, that is, nominal foodgrain prices deflated by an appropriate price index to remove general inflationary (or deflationary) price movements. In addition to domestic supply, commercial imports (M) and P. L. 480 shipments (I) provide foodgrains for consumption.³ Although the latter is clearly a policy variable, commercial imports could be viewed as an endogenous variable functionally related to world and domestic prices and to other variables. Because many recipient countries now control commercial imports, they are also viewed here as subject to policy determination. Demand (D) depends on prices (P), again expressed at the producer level, real income (Y), and the number of consumers or population (N): $D = D(P, Y, N)$. One feature of this demand function is the exclusion of consumption goods other than foodgrains; that is, the cross elasticities are all zero. The results obtained below will not be seriously altered if food is truly independent of other budget items and only minor amounts of nongrain foods are utilized in diets.

This aggregate model treats demand of producers for their own produce as a part of total demand and consequently domestic supply represents total output rather than marketed surplus. In a comparative statics framework, the new equilibrium attained after P. L. 480 shipments increase or decrease will be identical under either specification. One must, however, define elasticities and other parameters accordingly.

¹ Fisher [3] developed this basic model. My formulation differs from his in only two respects: (1) it includes variables for commercial imports, population, real income, and government investment in foodgrain production; and (2) it uses the ratio of shipments to quantity demanded (total utilization) rather than the ratio to domestic output.

² In crop production, output adjustments will lag behind price changes and the lag will, in turn, influence the time required to reach a new, stable equilibrium. This model provides the new equilibrium but not the path of adjustment.

³ More generally, of course, food aid from other countries as well as multilateral agencies should be included when it enters regular distribution channels. Although only P. L. 480 shipments are referred to here, they should be interpreted in the more general context.

With the aggregate specification above, the market-clearing equation, with all variables defined on an annual basis, will be $S(P, G) + M + I = D(P, Y, N)$. Differentiating totally with respect to I and converting to elasticities, we obtain the following equation: $E(S, P) E(P, I) (S/D) + E(S, G) E(G, I) + E(M, I) + 1 = E(D, P) E(P, I) + E(D, Y) E(Y, I) + E(D, N) E(N, I)$, where $E(S, P)$, for example, is the elasticity of domestic supply with respect to price. Each $E(,)$ is the usual elasticity except that changes in M and I are defined as proportional to D : that is, $\partial'/_D$ and $\partial^M/_D$, not $\partial'/_I$ and $\partial^M/_M$, respectively.

Inasmuch as our purpose is to determine the effect of P. L. 480 shipments on prices, solving for $E(P, I)$ gives the desired relationship:

$$(1) \quad E(P, I) = \frac{E(D, Y)E(Y, I) + E(D, N)E(N, I) - [E(S, G)E(G, I) + E(M, I) + 1]}{(S/D)E(S, P) + |E(D, P)|}$$

where $E(P, I)$ is defined as the percentage change in price induced by a 1-percent change in the ratio of P. L. 480 shipments to total utilization.

Because the concept of a derivative is for infinitesimal changes in variables, equation (1) gives only a first approximation for discrete changes in shipments. The larger the change in the proportion of total utilization provided by P. L. 480, the less exact will equation (1) be. Accuracy is increased, however, when elasticities are constant over the range of consideration, that is, for double logarithmic functional forms.

To study the percentage change in domestic quantity supplied arising from a 1-percent change in P. L. 480's contribution to total utilization, $E(S, I)$, we multiply equation (1) by the elasticity of domestic supply, a process which gives

$$(2) \quad E(S, I) = E(P, I)E(S, P).$$

The next section reports the results obtained when equations (1) and (2) are applied to parameters for a hypothetical country. In order to concentrate primarily on the disincentive effects, we obtain the numerical estimates by assuming several elasticities equal to zero. Specifically, we assume that population remains constant during adjustment and that shipments do not influence government investment in food production or purchases of commercial imports: $E(N, I) = E(G, I) = E(M, I) = 0$. Qualitative discussion of each zero assumption follows our examination of the disincentive effects.

Disincentive Effects in a Hypothetical Country

Estimates are obtained for the price-output effects induced by a "permanent" change in P. L. 480 shipments to a hypothetical country with

Table 1. Price and domestic output effects of a 1-percent change in P.L. 480's contribution to total foodgrain utilization in a hypothetical country

Price elasticity of demand ^a	Elasticity of supply ^a					
	0.0	0.1	0.2	0.3	0.4	0.5
	<i>price effects^b</i>					
-0.2	4.25	2.88	2.18	1.75	1.47	1.26
-0.4	2.13	1.72	1.44	1.24	1.09	0.97
-0.6	1.42	1.22	1.08	0.96	0.87	0.79
-0.8	1.06	0.95	0.86	0.78	0.72	0.67
-1.0	0.85	0.78	0.71	0.66	0.62	0.58
	<i>domestic output effects^b</i>					
-0.2	0	0.29	0.44	0.53	0.59	0.63
-0.4	0	.17	.29	.37	.44	.49
-0.6	0	.12	.22	.29	.35	.40
-0.8	0	.09	.17	.24	.29	.33
-1.0	0	0.08	0.14	0.20	0.25	0.29

^a All elasticities pertain to total quantities and not partial quantities. The latter have been commonly referred to in the literature as "marketed surpluses."

^b Effects are negative.

variable supply and demand (price) elasticities.⁴ The analysis—comparative statics—is more appropriate for a traditional, static agriculture than for a modern, dynamic one and the results depend on the previously specified assumptions.

Numerical estimates

Consider a country in which foodgrain production accounts for 30 percent of aggregate real income, $E(Y, I) = 0.3$; the income elasticity for foodgrains, $E(D, Y)$, is 0.5; and initially P. L. 480 provides 5 percent of total utilization. The ranges chosen as relevant for supply and demand elasticities, although subjective, are consistent with available empirical work in less-developed countries. Applying equations (1) and (2) to these ranges gives estimates (Table 1) of the price–output effects resulting from a 1-percent change in the ratio of P. L. 480 to total utilization.⁵ All estimates are negative if shipments increase and positive if they de-

⁴ This approach differs from Mann's recent empirical study of P. L. 480 shipments to India [7]. He estimates the parameters and then investigates a "one-shot" change in shipments (shipments increase by one unit in a period and then return to their original level), whereas I rely on parameter estimates of other workers and consider a "permanent" or sustained change in shipments and compare the new equilibrium with the former one.

⁵ A 1-percent discrete change in P. L. 480's contribution to utilization leads to a change in actual shipments greater than or equal to 20 percent. Equality holds for either a zero price elasticity of demand or an infinitely elastic supply; both are special cases not considered here. The maximum change, 21.3 percent, occurs when the elasticity of supply is zero.

crease. For smaller values of either the income elasticity of demand or the proportion of foodgrains in real income, the counteracting influence of income diminishes and price-output effects enlarge. They decrease, however, if shipments are imperfect substitutes for domestically produced foodgrains, and therefore a price differential exists between apparently equivalent products.

Examination of the data in Table 1 reveals considerable variation in the magnitude of the effects. As one would expect, larger price effects correspond to the lower values of supply and demand elasticities. At the lower extreme permitted by the assumed elasticities, a 1-percent increase in P. L. 480's contribution to total utilization induces a 4.25-percent decline in prices. When demand elasticity is at its upper bound, the price effects are quite insensitive to changes in the elasticity of supply, ranging from 0.85 percent for a completely inelastic domestic supply to 0.58 percent for a supply elasticity of one-half. The output effects vary less overall than price, ranging from zero for a completely inelastic supply to 0.63 when demand elasticity is minimum and supply elasticity maximum.

When the elasticity of supply is zero, prices must absorb all the shock of a change in P. L. 480 shipments. Here we have a redistribution of income away from the agricultural sector; the amount depends on the size of the price change and varies from 0.85 to 4.25 percent.

Next, consider what would happen to prices and output if shipments were completely terminated. Because the estimates are for a 1-percent change in P. L. 480's contribution to total utilization, and they initially contribute 5 percent, termination of shipments would increase prices and output by approximately five times the estimates given in Table 1. Thus, if the true elasticities of supply and demand were 0.2 and -0.6 , respectively, terminating shipments would increase prices by 5.4 percent and domestic output by 1.1 percent.

It is clear that for many possible elasticity combinations, the disincentive effects of marginal (1-percent) changes in shipments are not substantial. And even if shipments contributed 5 percent of total utilization, which is not atypical, and were then terminated, the *ceteris paribus* disincentive effects would be relatively insignificant in many cases, especially compared with other factors operating concurrently which have been omitted in arriving at the Table 1 estimates.

Relative price changes

In interpreting the results in Table 1, we have not considered the relative prices of foodgrains and other consumption commodities. As P. L. 480 shipments increase, real income increases, thus raising demand for all normal goods. If we assume less than infinitely elastic supplies, prices of all commodities except foodgrains increase. Thus, the decline in real prices to

foodgrain producers would be somewhat greater than the estimates given in Table 1.

The direct increase in real income from shipments—the only increase included in the estimates—does not necessarily exhaust P. L. 480's total impact on real income. If shipments stimulate *incremental* government investment programs which raise real incomes, an indirect increase in foodgrain demand will follow.⁶ In any specific case, this can be an important benefit from food aid. But to argue that the increased foodgrain demand will likely neutralize any disincentive effects may be misleading.

One argument pertaining to inflation runs as follows: The possibility of inflation restricts government investment; foodgrains are a basic wage good and their prices are a major component of general prices; thus, additional food aid supplies permit government investment programs to expand without as much danger of inflation. The resulting rise in real incomes generated by investment programs increases foodgrain demand and tends to neutralize the disincentive effects. This line of reasoning implicitly allows the full burden of restraining general inflation to fall on foodgrain producers while prices of other commodities tend to rise. If the income elasticity of demand for foodgrains is less than unity for consumers who benefit from the higher incomes, the estimates given in Table 1 understate the decline in real foodgrain prices. Indeed, the argument that food aid restrains inflation and permits *incremental* investment seems more like a technical explanation of (potential) neglect of the welfare of foodgrain producers than an explanation of why food aid does not lead to disincentive effects.

Relaxing zero assumptions

When P. L. 480 shipments lead to *incremental* investment specifically in food production, that is, $E(G, I) > 0$, the output effect will certainly tend to be counteracted, even if foodgrain prices decline, by falling costs of production. The extent to which such investment increases food production depends on the value of $E(S, G)$, the return on investment in food production. The self-help measures incorporated into the 1966 Food-for-Peace Act not only try to insure that $E(G, I)$ be positive but specify critical investments where $E(S, G)$ may be high.

The influence of population—omitted in the Table 1 estimates—can be examined via equation (1). Consider the following terms from the numerator: $E(D, Y)E(Y, I) + E(D, N)E(N, I) - 1$, where $E(N, I)$ is interpreted as the percentage change in population during the adjustment period. When this expression equals zero, the disincentive effects will also be

⁶ I am indebted to an anonymous reviewer for stressing the importance of *incremental* government investment.

zero. For our hypothetical country, $E(D, Y)E(Y, I) = 0.15$, and the disincentive effects vanish when $E(D, N)E(N, I) = 0.85$. If demand increases proportionally to population changes, then $E(D, N) = 1$, and only an 0.85-percent increase in population will be required to neutralize the disincentive effects. Even with demand increases somewhat less than proportional to population increases, surprisingly small growths in population counteract disincentive effects of increased P.L. 480 shipments.

A similar analysis for commercial imports leads to the same conclusion: annual commercial imports would need to decline by 85 percent of the quantity of P. L. 480 shipments in order to neutralize the disincentive effects. Although such a high displacement seems improbable, especially since none is intended under P. L. 480 policy, there will be strong pressures for some displacement to occur. The pressure under government control of imports will be to divert foreign exchange to other pressing needs; for private imports, the lower domestic prices will reduce the profitability of imports.

Disincentive Effects: Estimates with Indian Parameters

It will be helpful to estimate the effects by using estimates of parameter values for a specific country. For this purpose, India has been selected; but we should bear in mind that the abstract framework only partially corresponds to any particular country. The statistics needed for India are elasticities of demand (price and income) and supply, the ratio of shipments to utilization of cereals,⁷ and the proportion of real income from cereals.

The elasticity estimates were selected from several empirical studies and are shown in Table 2. While the final selections were arbitrary, they are within the ranges found in currently available research. For the supply elasticity, the selected value is near the upper value in the range, because, excluding Mann, the estimates are all for acreage responses, which represent lower bounds on output elasticities so long as yield responses to price are nonnegative. The demand elasticities reported by Mann and NCAER are at the wholesale level; so we need to assume a constant percentage marketing margin between wholesalers and producers in order to use their estimates unaltered.

During the period from 1956-57 through 1961-62, annual P. L. 480 shipments (Title I) of cereals to India averaged 2.78 million metric tons, ranging from 1.76 to 3.64 million tons [13]. They averaged 5 percent of

⁷ For direct comparability, only cereals are considered rather than foodgrains (cereals plus pulses). Moreover, the analysis includes only Title I sales because other shipments during the period from 1956-57 to 1961-62 were primarily for programs falling outside the conceptual framework of this article—for example, school lunch and emergency relief; there were no Title IV shipments during this period.

Table 2. Empirical and selected elasticity estimates for cereals in India

Type	Researcher	Period	Value
Income	Mann [7]	1957-1963	0.210
	NCAER [8]	1938-39-1959-60	0.460
	All India Survey [9] ^a	1964-65	0.240
	Selecte ^d	1956-57-1961-62	0.300
Demand ^b	Mann [7]	1957-1963	-0.342
	NCAER [8]	1938-39-1959-60	-0.340
	Selecte ^d	1956-57-1961-62	-0.340
	Mann [7]	1957-1963	0.275
Supply ^c	NCAER [8]	1938-39-1957-58	
	rice		0.220
	wheat		0.160
	Krishna [6]	1914-1945	
	rice		0.310
	wheat		0.080
	Selecte ^d	1956-57-1961-62	0.250

^a Value estimate, developmental area, ungrouped data.

^b Price elasticity.

^c NCAER's and Krishna's are acreage responses; Mann's is per capita output response.

annual total utilization during the period [7, p. 131]. The contribution of agricultural production to national income averaged 46.5 percent from 1956-57 to 1961-62 and cereals carried an index weight of 58.3 percent [11]. Consequently, cereals averaged 27 percent of the total income index.

Using the framework outlined above, we can investigate the following questions:

1. What would have been the price-output effects of a "marginal" change of 1 percent (this is equal to about a 20-percent change in actual shipments) in P. L. 480's contribution to cereal utilization?

2. In the absence of Title I shipments, what would have been the probable prices and domestic output?

By applying equations (1) and (2) to answer the question of a "marginal" change in shipments, we obtain the following estimates: price effect, 1.58 percent, and domestic output effect, 0.40 percent. In brief, an increase in average annual shipments of 560 thousand metric tons (20 percent) would have decreased prices of cereals 1.58 percent and annual domestic production 0.40 percent.

The second question, although perhaps unrealistic politically, merits consideration because of the criticism P. L. 480 shipments have received from distinguished economists who argue that they are a serious disincentive to agricultural development in recipient countries [4, p. 4; 12]. Using the mean value of S/D , we find that the estimated ceteris paribus prices and output in the absence of Title I shipments would have been 6.7 and 1.7 percent higher, respectively. Even though the estimating formulas

are less exact for such large shifts in P. L. 480 shipments, these estimates do approximate the effects of terminating shipments. We see that the adjustment occurs primarily in prices and consequently income distribution, and to a lesser extent in domestic output.

Related Economic Effects

From a policy viewpoint, interest focuses on the normative aspects of these disincentive effects. On what criteria do we base judgments about the desirability of increasing shipments, to India for example, with this knowledge of their expected price-output effects? This section discusses briefly three effects directly related to disincentives; each needs to be included in an evaluation of the disincentive effect in particular and of food aid in general.

Consumption levels

Presumably the desire to raise nutritional levels motivates many recipient countries to contract for Title I shipments. Suppose we consider India's total utilization of cereals as 100 units (net of imports, which we assume constant), of which Title I shipments provide 5 and domestic output 95. Then, if shipments increase one unit, domestic output decreases by $(0.40)(0.95) = 0.38$ units and food utilization increases by 0.62 units or percent. Although this is likely to diminish somewhat if commercial imports decline, the net effect will be a modest improvement in overall nutrition. Moreover, if the food can be channeled to segments of the population where it will increase short- or long-run labor productivity, there will be a second benefit to the nation's income in addition to better diets.

Income distribution

Next consider the income redistributive effects of shipments sold through regular market channels or government shops. Bypassing the Indian case, assume a unitary price elasticity of demand for cereals in our hypothetical country so that total revenue from their sale is constant. Initially the government receives 5 percent of foodgrain revenue. But with a one-unit increase in P. L. 480's contribution, the producers' share declines to 94.05 percent and the government receives an additional 0.95 percent, or a total of 5.95 percent, the result being approximately the same for all supply elasticities.⁸ The government could, by returning to producers on a per unit basis its 0.95 percent revenue gain, entirely eliminate the disin-

⁸ Since only marketed surplus earns revenue, some portion of the loss is implicit rather than monetary. If producers value retained output at market prices, the results above are valid. The loss will be reduced if producers' valuation of retained output is independent of market prices. Similar calculations could be made for the revenue position of the distribution sector.

centive effect. If, however, it spent this additional revenue on general investment programs, prices of nonfood commodities would rise and consequently the real income position of producers would worsen still further: that is, the terms of trade would turn against producers by more than the amount implied by the absolute price declines in Table 1.

But what if the price elasticity of demand is less than unity? Then consumers devote less money income to cereals; more remains to spend on other consumer commodities and thus their prices rise. Again the real income position of producers declines by more than the amount implied by the absolute price changes of the cereals they sell. Indeed, because total revenue to producers and the government declines, it would be impossible to subsidize producers (say through price supports) without another source of tax revenue.

In summary, an increase in P. L. 480 shipments is likely to redistribute income as follows: lower prices and less output combine to decrease money incomes to domestic producers by more than either one evaluated alone; higher prices of items purchased by producers cause real incomes to decline by somewhat more than money incomes.

Returning to the example with estimates of parameters for India, if initially shipments provide 5 of 100 units, an increase to 6 units will decrease producers' money incomes from cereals by 1.8 percent. This, coupled with even lower real incomes and the possibility of larger shifts in P. L. 480 shipments, could impose severe hardships on the welfare of a relatively poor rural sector.

Resource allocations

Although difficult to evaluate in the absence of field research, the effects of shipments on resource use plays an important role in the recipient country's growth. Three different effects can be isolated conceptually. The first is the direct "saving" of farm resources when domestic output declines. Are the displaced resources shifted into other enterprises—export crop production, for example—or do they become unemployed? Indeed, a shift of resources to some desirable alternatives may be consistent with the policies of a country lacking comparative advantage in foodgrain production and requiring more production of export crops to expand foreign exchange earnings.

A second effect occurs if commercial imports are allowed to decline when P. L. 480 shipments rise. Such displacement of regular trade, although unwelcomed by third exporting countries, saves foreign exchange which is needed to buy capital for development programs. There are two empirical questions here: Does a shortage of foreign exchange impose a severe constraint on development programs? To what extent do P. L. 480 shipments displace commercial imports of similar commodities?

If domestic output and commercial imports remain unaltered despite changes in these shipments, or if they are only negligibly affected, then a change in such shipments will be taken up by incremental consumption or perhaps stock changes in the short run. But a potential for resource reallocation still exists. The revenue derived by the government from the sale of P. L. 480 shipments, an indirect tax on producers, may enable it to shift resources into needed development programs and perhaps to bring some unused resources into use. For some countries, revenues from food aid sales could be an effective method of tax collection; nevertheless, the adverse welfare implications for foodgrain producers should not go unmentioned.

On the whole, although the related effects of P. L. 480 (Title I) on consumption and incomes of producers are not insignificant, in order to measure the value of shipments, we need to quantify and analyze the relationships among the resource allocations which they stimulate. In particular, the effect on domestic output should not be viewed in isolation and as a totally negative result. Instead, the resources released from domestic production, as well as commercial import displacement, could be viewed more profitably in terms of the new production possibilities which they permit.

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Export Quotas and Allocative Efficiency Under Market Instability*

RICARDO FFRENCH-DAVIS M.

In a stable environment the existence of economic distortions leads to the use of taxes and subsidies rather than of quotas. The purpose of this article is to explore whether the existence of market instability can change that conclusion. In the case of fluctuations originating in domestic supply, export quotas will tend to destabilize domestic consumer prices and, whenever demand elasticities are low, will increase fluctuations in farmers' income. On the other hand, the case of instability originating in foreign markets is more favorable for quotas. In a free trade situation, all the external price instability carries over to the internal market. A quota scheme, on the contrary, stops instability at the country's frontiers. It is when markets are unstable, then, and instability is concentrated in external markets, that we find an argument for quotas. However, it has to be shown that quotas reduce price and income fluctuations in a degree that more than compensates for the reduction of export returns resulting from the introduction of quotas.

EXPORT quotas have been extensively used in some countries. Two of the most frequently mentioned reasons for their use are (1) that quotas are a good way to keep food prices low, and (2) that quotas lead to an improvement of the terms of trade. The first reason is applicable to exportable products which are consumed primarily in the domestic market. The second is applicable to products sold mainly in external markets where they face an imperfectly elastic demand.

The resource allocation effects of export quotas have been extensively treated in the economic literature. Moreover, the analysis of these effects is quite similar to that of import quotas, tariffs, export taxes, and other forms of restrictions on trade. It has been shown, for example, that the allocative effects of export taxes and quotas may be identical, although their redistributive effects differ, with quotas having a poor standing [9, 11].

However, there is an aspect which remains almost untouched in the literature. It is that of the allocative effects of export quotas in the face of market instability. It is in this different framework—of supply and demand fluctuations—where quotas play a crucially different role from that of export taxes. The primary consequence of a quota is that it introduces a barrier between internal and external markets, a kind of barrier that, in

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the face of instability, differs widely from taxes, tariffs, import deposits, and other hindrances to trade. The latter introduce differences between external and internal prices, as the quota does, but price changes are transmitted from one market to another. On the other hand, whenever the quota is effective, price changes in the external market do not extend to the domestic one.

The purpose of this article is to explore whether the existence of price fluctuations ends in a case for quotas or a further case against quotas.

Throughout the analysis it will be assumed that there are no economic distortions except those explicitly mentioned,¹ that there is no economic uncertainty as a consequence of the way the quota is fixed, and that the quota is always effective, that is, that desired exports always exceed the quota allowed by the economic authorities.

In the first section the traditional analysis of the effects of export quotas upon resource allocation and efficiency in stable markets is presented. In the second section the effects of market instability are discussed. The stability of domestic consumer prices and farmers' income is analysed in the cases of free exports, of a closed economy, and of export quotas. A distinction is made between instability originating in domestic markets and that originating in external markets. Then a brief analysis of the effects of instability upon allocative efficiency is presented. The arguments previously discussed are tied together in a benefit-cost analysis of quotas. It is then shown that even though a quota, in the face of market instability, may improve the allocative efficiency as compared with free exports, it will not lead to an optimum allocation. Finally, some policy implications are discussed.

The Stable Environment

The stable welfare cost

Let us consider first a fully competitive world with no economic distortions, and a country that imposes an export quota on an exportable good, say an agricultural commodity. This export quota, expressed in physical units, is determined at the beginning of the planting or production period and is kept constant for the whole agricultural period.² Thus, there is no uncertainty attached to the determination of the size of the quota. Let us call X the product and S_x the quota. Furthermore, we will

¹ For our purposes, distortions can be divided into two groups: (a) those like infant industry, externalities, wage differentials, and unemployment, and (b) price instability. For the first, quotas are on occasion a *second-best* policy but tariffs, taxes, subsidies, and direct public investment are equal or better policies. For the second type, quotas play a crucially different role. That is the reason why we concentrate on the effect of quotas on price instability.

² The quota should be adjusted from period to period to take into account the effect of economic growth on the supply of and demand for X .

disregard the distributive effects derived from the change in domestic prices relative to export prices and we will assume that our country has no influence on international prices so that the external demand is perfectly elastic. The situation is represented in Figure 1. P_i is the net real price received by exporters (f.a.s.), D is the full employment domestic demand curve for X , and S is the supply curve of X . Exports, then, amount to $(Q - q)$. Now, let us assume that the export quota is $S_x = (Q' - q') < (Q - q)$, so that it has real economic effects. Exports decrease by $(Q - Q') + (q' - q)$ and the foreign exchange proceeds fall by that amount times P_i . That is the cost side of the benefit-cost analysis of the action. The benefit side is derived from the increased consumption plus the reduction in the quantity of resources utilized and shifted to some other use. Benefits tend to be equal to

$$\int_q^{q'} D(X)dX + \int_{Q'}^Q S(X)dX.$$

The net effect is equal to the sum of the areas of the triangles abc and def . In other words, there is a *net* loss in both consumption and production: in consumption, because it is increased to a point where the marginal utility (P') is below the opportunity cost of the foreign exchange foregone

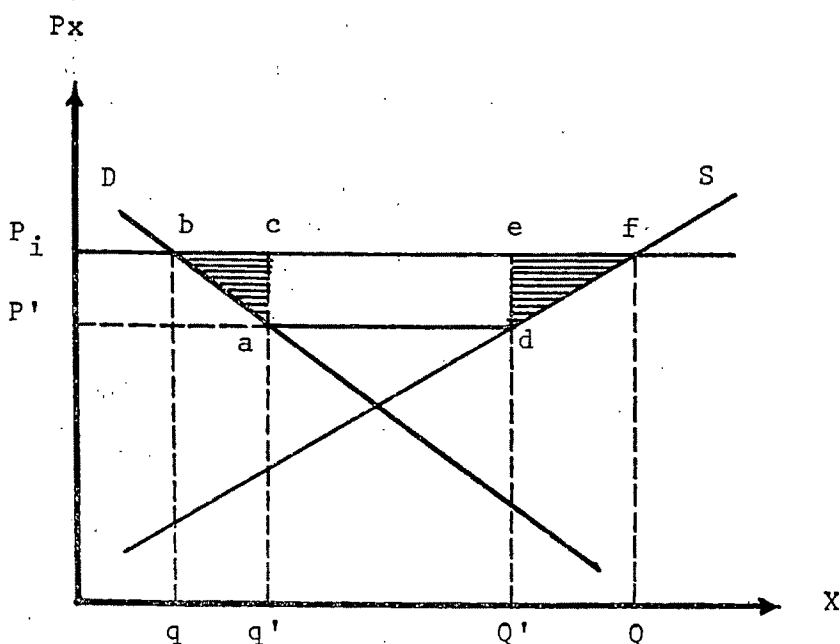


Figure 1. The welfare effects of a quota: the stable environment

(P_i) per unit of X not exported; in production, because it is reduced to a point where the opportunity cost of the resources saved (P') is lower than the social value of the foreign exchange foregone.

In summary, if we really lived in a world with no domestic economic distortions and with given external prices, the result of imposing quotas would be a fall in net national product.³ For the sake of simplicity, let us call the net effect the "stable welfare cost" (SWC).

Distributive effect of food prices

But quotas could have been designed to keep food prices low. That is, as a consequence of the quota, the domestic price, in Figure 1, is lowered to P' . The argument runs as follows: Food is intensively consumed by low-income people; therefore, it is said, keeping food prices low is a way to redistribute real income.

Nevertheless, it must be kept in mind that (a) high-income people as well as low-income people consume agricultural foodstuffs; (b) there is a net loss in national income due to malallocation of resources (the SWC effect); (c) there is a tendency to some regressive redistribution of income based on the assignment of the quotas, as is shown below; and (d) the products affected by quotas, at least in some countries, tend to be labor-intensive in their production.⁴ Hence, the natural decrease in production resulting from a move toward export quotas tends to reduce the relative demand for labor, especially unskilled labor. If this is true, even if workers consume intensively the above-mentioned products, the final effect will be a change in the distribution of income unfavorable to labor [12, 15]. Paradoxically, this outcome is the opposite of the one expected. The most probable reason why authorities persist in such policies is that the favorable aspect (lowering wage-goods prices) emerges in the very short run, whereas the negative ones (malallocations of resources) appear only in the medium or long run. Moreover, it is difficult in connection with the latter to trace the causation-effect line.

In general, the best policy is the one that works directly on the source of distortion of the economic apparatus. Accordingly, if there is a political consensus that income distribution is "unjust," redistribution should be effected in other ways—those that work openly and directly on income distribution without impairing excessively the working of the price system.⁵

³ We assume that X is produced by domestic factors. Otherwise, the quota could be a method of shifting income from foreign-owned capital toward domestic consumers. Hence, the conclusions might change. Nevertheless, this would not be the best way to tax foreign-owned capital.

⁴ The products subject to export quotas in Chile in the last decade [1] have been among those most labor-intensive in their production [4].

⁵ This method is exemplified graphically by Bhagwati and Ramaswami [2] and H. G. Johnson [7]. In a somewhat different context, that of foreign exchange policy, see Mundell [13].

Terms-of-trade effect

Alternatively, the quota could serve the purpose of increasing the price received for the country's exports. In this case we must relax the assumption that international prices are given. The quota—or any other impediment to trade, such as an export tax—will reduce the quantity exported. If the external demand faced is not perfectly elastic, the price received will increase. So, as a result of the quota, the export price would be increased. But is this synonymous with a better position? Let us represent in Figure 2 the short-run internal excess supply (total supply minus internal demand) and the short-run external demand. Call them S_e and D_e respectively. The point of competitive equilibrium corresponds to the price P_i . The marginal revenue is given by I . The maximum-benefit quantity supplied is X_m , and P_m represents the optimum price.⁶ That is, when exports are X_m , the marginal cost of reducing the trade in X is equal to the marginal benefit of increasing the export price. Hence, if the quota is equal to X_m , then we find that it is the optimum quota. Any quota above X_m and below X_c would bring an improvement over the competitive situation and, consequently, a higher (short-run) national income. Any

⁶ This analysis is only partial. We have not taken explicit account of the secondary effects on other exports and on imports: that is, that because the markets of all products are interrelated in some degree, quotas on some exports will induce either an increase in other exports or a substitution of some imports. However, the conclusions are not altered by our simplification.

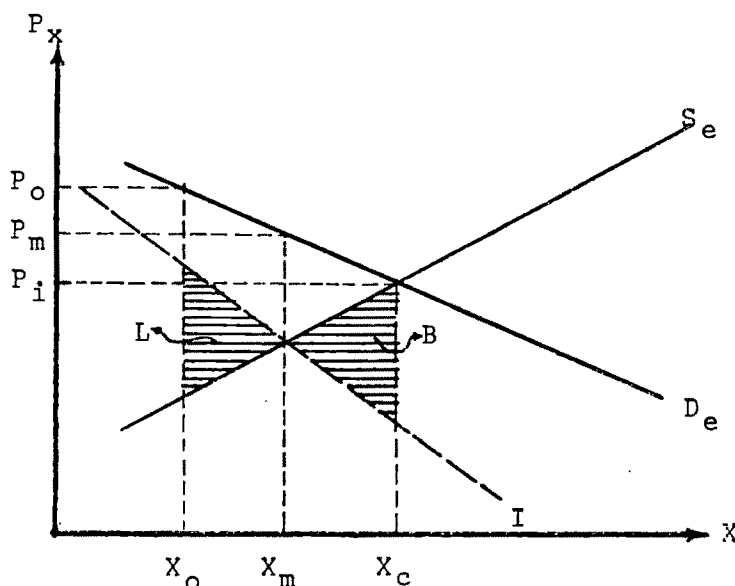


Figure 2. Optimum export quota

quota below X_0 , even though implying higher export prices, would represent an inferior position, where X_0 is such that the welfare value of the triangle L is equal to that of B in Figure 2.

We can easily see that this argument in favor of a quota falls in the same category as the so-called "optimum tax" or "optimum tariff." Correspondingly, it is subject to the same lengthy list of qualifications. The most important, in my judgment, is the difference in elasticities through the course of time.

First, there is, in general, some sluggishness in the adjustment of markets. Consumers and producers do not reach long-run equilibrium immediately, partly because of immobilities and partly because of uncertainty about whether the price change is permanent or transitory. A second source of differences between export taxes and quotas is the following: There are rich unexploited lands, suitable for the growth of tropical products, which tend to be brought under production by any strong monopolistic pricing or continued shortage of supply. As a consequence, the demand faced by countries imposing quotas shifts to the left and tends to become more elastic.⁷ For proof, we can look at the coffee and sugar markets. The same holds for induced innovations in the production of synthetic substitutes for raw materials.

Distributive effects of export taxes and quotas

But we still face an unsettled question. We have said that quotas and export taxes have similar allocative effects. They differ, however, in their distributive effects. To illustrate this difference, let us go back to Figure 1.

Although the internal price has become P' , the external price faced by exporters is still P_1 . Therefore, there will be an excess demand for export quotas. Necessarily, some rationing device will have to be designed to distribute the quota among the potential exporters. No objective "traditional" device is at hand. All such devices give capital gains to those who are assigned some part of the quota.⁸

⁷ There is a frequent misconception with respect to the elasticity faced by any given country. In some literature dealing with the elasticity approach to devaluations, the idea prevails that the demand for primary products is quite inelastic. This may be true for the world as a whole, but it is not necessarily so when we consider the demand for the exports of a particular country, a coffee-producing country like Costa Rica, for example. The demand for Costa Rica's coffee exports would be, not inelastic, but probably close to perfectly elastic. Such a nearly perfect elasticity is the relevant one for policy purposes in Costa Rica.

⁸ A nontraditional device—auctioning of quotas—could in principle retain all of the capital gains for the auctioneer, that is, for the governmental institution. Nevertheless, for the correct performance of an auctioning system there must be many auctioneers competing among themselves. In Latin America there have been some experiences in the field of auctioning import quotas. For a description and analysis of one of them, see Kafka [8].

Generally speaking, the higher the number of producers of X , the higher is the probability that the quotas are received by some few exporters who purchase the product from small farmers, who tend to obtain only the equivalent of the price P' . In fact, it is difficult to insure that every producer will receive a share of the quota and that this quota will become a constant proportion of each producer's output. Because there is no objective, neutral device for distributing the quotas, those benefited are probably the most influential among them. The system carries an inevitable corollary of, at least, suspicion with respect to the objectivity of the assignment of the quotas. This outcome is highly undesirable and opposed to governmental efforts, in developing countries, towards creating a framework of morality and austerity.

The same result with respect to the volume of exports and domestic price of the product, avoiding the probable regressive distributive effects, can be reached by imposing an ad valorem export tax equal to $(P_i - P')/P_i$.⁹ The proceeds of the tax would be equal to the capital gains (or rents) involved in the quota scheme.

In summary, if a quota is justified, it is clear that the tax (tariff) will also be justified, the latter being somewhat better.

The Unstable Environment

Let us reimpose the assumptions that we face a perfectly elastic external demand and that there are better devices for redistributing income than keeping food prices low.

From what has been said in the first section, we know that we are left with SWC as the effect of the imposition of an export quota on the framework described by our earlier assumptions. But, up to this point, we have been implicitly assuming that the relevant markets (prices and quantities) are stable. In many cases this is a strong and unrealistic assumption. Further on, we will relax this assumption in order to analyze the implications of instability, that is, of fluctuations around some given trend of prices and/or quantities produced or demanded.

The effects on resource allocation discussed in the first section, with one modification to be analyzed later, are still valid, but they give a partial view. Now we try to complete the picture. If we are to change our previous conclusions—that quotas generate malallocation of resources—we

⁹It is supposed that the quota scheme has been derived in such a way that all producers operate with similar marginal costs and that these are identical to the domestic price. Otherwise, it could happen that some producers, allotted a high quota, would produce up to a point where marginal costs exceeded the domestic price, climbing up to the level of the external price. Hence, (a) the SWC would be higher than we had previously estimated, and (b) tariffs, taxes, and quotas would differ in their real effects. For cases of nonequivalence of the real effects of quotas and tariffs, on the import side in a stable environment, see Bhagwati [3].

have to show that quotas, by preventing instability in the economy as a whole, more than compensate for their negative effects in a stable environment.

Instability is caused by changes in market conditions. Here, we will consider those changes reflected by fluctuations in the internal supply and by fluctuations in international prices. These changes in market conditions have multiple effects on the domestic economy. We will restrict our analysis to the effects of instability on consumer prices and farmer income.¹⁰

Internal market unstable

Suppose, first, that the internal market is unstable and the external one is stable. We have, alternatively, a closed economy, a free trade situation, and a quota equal to S_x . We start, in Figure 3, from the set (S, P_i) for free trade and (S, P') for the use of quotas. Suppose that because of bad weather conditions the supply curve shifts left to S_1 in the next period. Under free trade, the domestic price will be unaffected. Under the quota scheme, the internal price will rise to P_1 . However, it will remain below that prevailing in external markets, because the quota is assumed to remain effective.

The increase in the internal price under the quota scheme might even

¹⁰ Among the other effects, the most important, in my judgment, is the likely sectoral short-run unemployment created by instability.

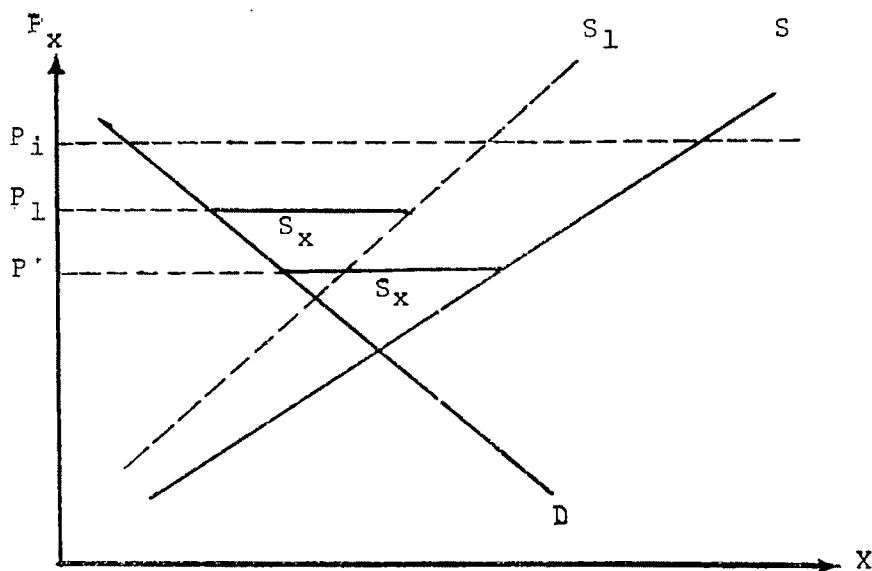


Figure 3. Unstable internal supply

be relatively greater than under a closed economy. In fact, if the short-run supply elasticity is zero and the demand elasticity is constant, the percentage price change under a closed economy will be t/N , whereas that under the quota scheme will be $t/(1-s)N$, where t represents the percentage change in total supply, s represents the relative importance of the quota in total supply, and N is the price elasticity of internal consumer demand. If the supply elasticity is greater than zero, the sign of the difference is not changed. For the results to be reversed, the demand elasticity at the range of quota prices would have to be at least $1/(1-s)$ times that at the closed economy range.

Thus, we can see, free trade is one way of stabilizing internal prices. A quota scheme, whenever demand price elasticities do not increase strongly as the price rises, destabilizes them.

What happens to farmers' income? In the case of free trade, the change will depend exclusively on the change in supply. If Q is total supply and ΔQ represents the shift in it, the proportional change in income will be

$$\frac{\Delta Y}{Y} = \frac{\Delta Q}{Q} = t,$$

where the absolute change in farmers' income is equal to the change in export proceeds.

In a closed economy, farmers' income will fluctuate, depending on the price elasticity of demand. Only if the price elasticity is equal to one will income be stable. Under a quota, we find a somewhat different situation: income will be stable only when the weighted average elasticity (N_f) of domestic consumer demand (N) and that of exporters (N_e) is equal to one, where the weights are domestic consumption and exports, respectively, as shares of domestic output. As long as the quota is effective, the elasticity of the exporters' demand is zero. Accordingly, that of domestic consumers must be above one, for farmers' income to remain constant. The elasticity must be equal to $(1 + S_x/q) = E$, that is, unity plus the ratio of the quota to domestic consumption.¹¹

If consumer elasticity is above E , income will fall whenever supply falls

¹¹ That is, N_f is described by the following relation:

$$(1) \quad N_f = \frac{q}{Q} N + \frac{S_x}{Q} N_e,$$

where q is domestic consumption and Q is domestic output.

$$(2) \quad N_f = (-)1; \quad N_e = 0$$

by hypothesis. Then,

$$(3) \quad N = (-) \left(1 + \frac{S_x}{q} \right) = E = (-) \frac{q + S_x}{q} = (-) \frac{Q}{q}.$$

and vice versa. How big will the change be? As the elasticity approaches infinity, the change in the internal price approaches zero. As a consequence, the maximum change in farmers' income approaches

$$\frac{\Delta q}{q + S_x} = \frac{\Delta Q}{Q} = t.$$

Now, when the elasticity is below E , if supply falls, income will rise, and vice versa. It can be shown that if the elasticity is smaller than $E/2$, farmers' income will fluctuate proportionately more in the quota scheme than in the free trade case.¹² It is important to observe that the direction of change is different in the two cases. A fall in supply reduces farmers' income in the free trade case and increases it in the quota case (part of the former capital gains accrues to farmers as the excess supply curve shifts upward).

In summary, when the elasticity is smaller than $E/2$, farmers' income will be more unstable in a quota scheme.

External market unstable

Now we deal with the case where the internal market is stable and the external market unstable.

¹² We have

$$(4) \quad \frac{\Delta Y}{Y} = \frac{P' \Delta q + q \Delta P + S_x \Delta P}{(q + S_x) P'}$$

in the quota case, and

$$(5) \quad \frac{\Delta Y}{Y} = \frac{\Delta Q}{Q}$$

in the free trade case. If we make (4)+(5) equal to zero, we find the critical elasticity that makes both cases equally unstable. After some rearrangements, we get

$$(6) \quad N = -\frac{1}{2} \left(1 + \frac{S_x}{q} \right) = \frac{E}{2}$$

whenever S_x is effective. From (4) we also get

$$(7) \quad \frac{\Delta Y}{Y} = \left(\frac{1}{(1-s)N} + 1 \right) \frac{\Delta Q}{Q}$$

in general. From (4)+(5), we obtain

$$(8) \quad \frac{\Delta Y}{Y} = \left(\frac{1}{(1-s)N} + 2 \right) \frac{\Delta Q}{Q}.$$

We see, for example, that if $N = E/2$, then (8) becomes equal to zero. In our analysis, it is not necessary for the short-run elasticity of supply to be equal to zero. The same results hold if the shift in supply is equiproportional at every price. The latter makes our case a more general one. Nevertheless, it may happen that the shifts become less than proportional at lower prices. This would be the case if marginal lands offered conditions implying more instability than the average land. A slight change in (6) can take account of that fact. The result is a somewhat smaller critical elasticity.

In a free trade situation, all the external price instability carries over to the internal market. A quota scheme, on the other hand, stops instability at the country's frontiers.¹³ Thus, an effective export quota becomes a scheme appropriate for avoiding both price instability for consumers and income instability for producers. In any case, farmers' income is stabilized at a level below that corresponding to the average level in free trade. In fact, both price and quantities will always be equal to or below those in free trade. If world's supply rises enough, the quota no longer will be effective and external and internal prices will be identical. Whenever the quota is effective, domestic prices will be below external prices, and the quantity supplied, except for peculiar reactions toward risk or uncertainty, will be either the same as or lower than in the free trade case.

On the other hand, all the income instability will fall on the shoulders of exporters. This instability will affect only their capital gains (difference between external and internal prices) and can be reduced or eliminated through a flexible export tax related to deviations between actual and normal external prices. As a by-product, capital gains would be reduced or eliminated too. In any case, the instability of the economy as a whole is not eliminated; rather, it is transferred to the government.

Our results to this point are summarized in Table 1. It should be noted that the nature of the source of external instability is immaterial, provided that it is of a given size. On the other hand, the source of internal instability does make a difference. Our results apply strictly to changes in

¹³ For an alternative device to deal with external instability, and with internal instability originating in domestic demand, see D. G. Johnson [6] and Schultz [14].

Table 1. Changes in internal prices and farmer income under three systems

System	Percentage changes, under external stability and internal instability, in		Percentage changes, under external instability and internal stability, in	
	internal prices	farmer income	internal prices	farmer income
Free trade	0	t	$\frac{\Delta P_i}{P_i}$	$\frac{\Delta P_i}{P_i}$
Quota	$t/(1-s)N$	$\left[\frac{1}{(1-s)N} + 1 \right] t$	0	0
Closed economy	t/N	$\left[\frac{1}{N} + 1 \right] t$	0	0

domestic supply. Nevertheless, they can be easily extended to changes originating in demand.

The Effects of Instability

What are the effects of instability upon resource allocation? Instability involves allocative inefficiency whenever it imperils the correct working of the price mechanism as a resource assigner. As a consequence, instability is not necessarily bad from the economic point of view. Consider, for example, the instability of exporters' capital gains in the quota case. Such instability will tend to have no effect on resource allocation. Excess profits will be of a capital gains nature, originating in the positive difference between external and internal prices. The only role of that difference is to clear the market of domestic exporters and foreign importers, where the supply of domestic exporters is absolutely inelastic at the relevant prices. Thus, the price system is not playing, in this respect, a role in the allocation of domestic resources and, consequently, even though instability has distributive effects, it has no allocative effects.

Let us consider, then, cases where instability produces allocative effects.

With respect to farmers' income, instability makes it difficult to know whether changes in prices are giving the right signals or not. For example, the cobweb phenomenon derives from the failure to distinguish between trend and cyclical changes in prices. Moreover, uncertainty with respect to prices and income affects the structure and prices of inputs, sliding the entrepreneur toward a technology that allows more frequent changes in production. In this sense, the combination of inputs will not be as efficient as if instability is optimally coped with by economic policy. The degree to which uncertainty will affect the level and composition of production will depend, among other things, on the degree of risk aversion of farmers, the length of their economic horizons and the precise nature of their price and income expectations, the efficiency of the credit system, and their income level.¹⁴

Is there any cost involved in instability in consumer prices? The factors relevant for producers are also relevant for consumers. But their weights may be different. In fact, instability will also tend to affect the structure of consumption and lead away from an optimum one.

But there is an extra aspect. In an economy that has been the victim of inflation (deflation), expectations play a crucial role. Factual information and surveys show that consumers' expectations of changes in the price

¹⁴ It can be said that the cost of uncertainty and, consequently, the relative size of its impact on production are inversely proportional to the level of income. The cost of uncertainty is supposed to be a crucial factor at a subsistence level [5, 10].

level tend to be sensitive to pronounced increases (decreases) in consumer goods prices. In this respect, there are (a) an asymmetrical effect as to the weighting of increases and decreases of prices, and (b) an increasing price elasticity of expectations: that is, a product that has a weight of 10 percent in the price level will be implicitly given greater weight by consumers when a relative increase (decrease) occurs in the price of that product.¹⁵

Cost-Benefits of Quotas

In this section we tie together the three factors considered above: the stable welfare cost, the cost of instability in farmers' incomes, and the cost of instability in consumers' prices. Up to this point, we know the sign of each, for a given period, under our assumptions. Retaining the assumptions, we can do a benefit-cost analysis of quotas, searching for the size of each of the three effects. Here we will present a brief sketch of the approach which we believe should be taken.

A benefit-cost analysis, if performed in social terms, must measure the impact of export quotas on net national product (*NNP*). The impact depends on the existing situation before the introduction of the quota. Exclusively for expositional purposes, we suppose the initial situation to be that of free trade. As a consequence, if free trade proves to be better than quotas, the conclusion is not necessarily that a free trade policy must be followed but only that quotas ought to be rejected (and vice versa). In the analysis, as a consequence of the assumptions adopted, we do not consider terms of trade and redistributive effects. If they come to be important in practice, the analysis can be easily extended to consider both.

The general benefit-cost formula could be something like this:

$$\Delta NNP = f[V(y)] + g[V(p)] + h[i_p, e] - DWC,$$

where *NNP* represents net national product, *y* is farmers' income, *p* is the domestic price of the exportable product, *V* is a measure of instability, *i_p* is an index of downward price inflexibility, and *e* is an index of inflationary expectations.

For the first two terms of the cost-benefit equation, changes refer to fluctuations around the trend value. Consequently, changes with opposite signs tend to compensate each other. But what matters is the existence of fluctuations as such. Accordingly, *V* is used as the device to measure instability—that is, changes around the trend—and refers to the standard deviation (or some other measure of instability) of income and price

¹⁵ This hypothesis could be tested by correcting the expectations model of the Koyck-Cagan-Nerlove type by a partial price index. This index could have a coverage, for example, of 10 percent of the total index and include only those products whose prices increase proportionally more in each successive period.

changes under free trade versus those under quotas. Since we are evaluating from the point of view of quotas, if with free trade the standard deviation is larger, we get a benefit from quotas; if it is larger with quotas, we get a cost from quotas as they increase instability. Functions f and g would tend to be higher than one: the cost of instability increases with the size of the corresponding standard deviation. The parameters ought to be defined in such a way that the partial derivatives show the impact of $V(y)$ and $V(p)$ on NNP .

The third term describes the effect of price fluctuations on net national product through two stages of intermediaries: (a) inflation rate, and (b) downward price inflexibility (i_p) and inflationary expectations (e). The underlying idea is that a 10-percent increase in a given price will have a higher (short-run) effect on the general level of prices than a 10-percent fall. For example, upward shifts in the domestic prices of consumer goods may lead to wage increases. A subsequent, similar downward shift of those prices, in the face of downward price inflexibilities in the rest of the economy, will not be sufficient to eliminate the former increase in the general price level. Hence, the fluctuations will tend to have an inflationary bias. On the other hand, we have presented here our hypothesis that price fluctuations also are positively related to inflationary expectations and that these tend to lead to actual inflation. As a consequence, both downward price rigidity and inflationary expectations imply that price fluctuations tend to have an inflationary bias. Now, inflation can affect NNP in either direction, depending on whether positive (fall in sectoral unemployment) or negative (fall in the demand for money, excess investment in inventories, increase in accounting costs, and other distortions of the price system) effects of inflation on net national product predominate.

Finally, we have the direct welfare cost, which is simply SWC corrected by the asymmetrical effect of fluctuations on its size, and may be explained as follows: Let us represent in Figure 4 the domestic excess supply ($S - D = S_e$) and the external demand curves (the price lines). We start from a price P_i and a quota equal to $P'g (= S_e)$. The area ghi is equal to $abe + def$ of Figure 1. Now let us suppose that the international price rises to P_i' . The welfare cost then rises by $hikj$. If the price changes by an equal amount, but in the opposite direction, the welfare cost falls by $himl$. This last area is clearly smaller than the one attached to an increase in the international price. The same result holds if it is S_e that fluctuates. Consequently, price fluctuations around an average price P_i , even though compensating each other, give rise to an average welfare cost larger than the SWC for the price P_i . Let us call it DWC .¹⁶

¹⁶ It is very important to keep in mind the role of assumptions. If there are other distortions than those analyzed, it may happen that the quota, besides reducing in-

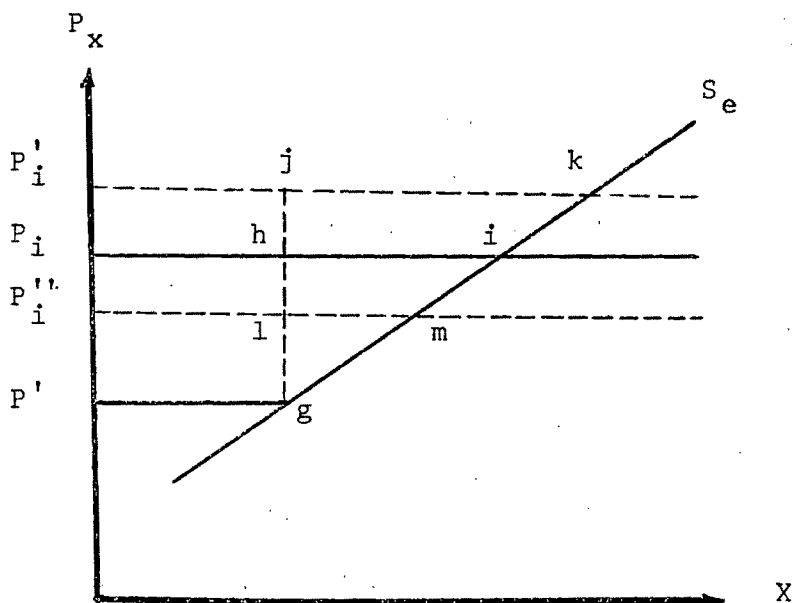


Figure 4. The direct welfare cost

For quotas to be preferred to free trade, the expected change in *NNP* must be positive: in other words, the quota *project* must render a positive net present value.

Export Quotas as a Second Best

Let us consider the case of external instability combined with internal stability. Suppose it has been shown that quotas on a given commodity improve economic efficiency as compared with free trade and an *ad valorem* tariff. In that setting we can show that an always effective quota does not optimize national income. In effect, we know that the quota has a positive marginal direct welfare cost (gh for P_1 in Figure 4). On the other hand, if the instability of farmer income and internal prices is completely eliminated, the marginal benefit of reducing the welfare cost of instability is zero. As a consequence, we know that we have gone beyond the optimum shrinkage of instability through quotas: the optimum point lies where marginal costs and benefits of quotas are equal and this necessarily leads to a marginal benefit above zero.

In summary, a better scheme is one that only partially eliminates insta-

stability costs, renders a direct welfare benefit. This could be the case if the market price of the foreign currency were above its social cost, a somewhat exotic case in developing countries, or if there were some other (more probable) distortions in the productive structure.

bility. This could be either (a) a not-always-effective but fixed quota, (b) a flexible (according to changes in international markets) quota, and/or (c) a flexible tariff. The flexibility referred to poses some additional problems that are beyond the scope of this article.

Some Policy Implications

We have shown that in a stable environment export quotas rank rather poorly. The existence of distortions such as unemployment, external economies, and undesirable income distribution leads to the use of tariffs, taxes, and subsidies rather than quotas.

We have introduced instability and analyzed the effect which it can have on the common conclusion that the use of quotas results in resource malallocation. We have considered two extreme cases: fluctuations originating in domestic supply and fluctuations originating in foreign markets. Beside the direct welfare costs of quotas, there appear to be indirect effects derived from fluctuations in consumer prices and farmers' incomes. In the first case, that of domestically produced fluctuations, we have found that export quotas tend to destabilize domestic consumer prices and, whenever demand elasticities are low, increase fluctuations in farmers' income. In fact, if there is external stability and if demand price elasticities are below $E/2$, each of the relevant aspects gives a negative balance for quotas. For policy purposes, it is easy to eliminate a large series of products from the list of commodities potentially subject to quotas, without any detailed econometric study but with some gross estimate of demand elasticities.

On the other hand, from what has been said in previous sections, it is clear that the combination of external instability with internal stability is less unfavorable (or more favorable) for quotas. It is in this case that more detailed empirical work becomes necessary in order to justify the inclusion of particular commodities in the list of export quotas.

In conclusion, in the absence of market instability, there is no objective defense for export quotas. It is when markets, particularly external markets, are unstable that we find a favorable argument for quotas. It is, then, the existence of external instability that brings a ray of hope to quota fans, but the light from that ray will not necessarily be bright enough to render an economic justification for quotas. It has to be shown that quotas reduce price and income fluctuations in a degree that more than compensates for the welfare cost involved in the reduction of export returns resulting from the introduction of quotas.

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Implications of Changes in the Methods of Wholesaling Meat Products

THOMAS T. STOUT AND MURRAY H. HAWKINS*

Both the meat procurement methods used by retail food stores and the associated pricing arrangements have undergone fundamental changes in recent years. These changes mark significant adjustments in market conduct in the wholesale meat trade. Although much of the change that is occurring is in response to structural and technological changes in the industry, the rate of change seems accelerated by the growth of meat programs. Programs represent a primitive but rapidly evolving systems-approach to meat procurement, distribution, and merchandising. Detailed product specifications, increased purchase by description direct from meat packers, formula pricing, and central warehousing figure prominently among the changes accompanying program development. The pressures which result from these changes impinge upon conventional attitudes and procedures in meat packing and in livestock production and marketing.

THIS ARTICLE is based on analysis of data obtained in interviews with meat directors¹ of thirteen chains and eleven affiliated groups operating in Ohio. The purchasing, merchandising, and policy-making authority of these directors affected the operating procedures of 930 affiliated stores and 538 chain stores in Ohio, plus some additional stores outside the state. These 1,468 stores accounted for between 70 and 90 percent of grocery sales in the metropolitan areas of Ohio.² Tabular data contained in this article allow comparisons between affiliated and chain organizations. Data for seven large chains, each of which has 20 or more stores, are separated from data for all chains, since many distinctive features of chain activities are associated with these larger firms.

Development of Meat Programs

Much of the change that is occurring in meat wholesaling is in response to structural and technological changes in the industry. But the rate of change seems accelerated by the growth of "meat programs"

* The research on which this article is based is reported in detail in an unpublished Ph.D. thesis by Murray Hawkins [2]. We are grateful to B. W. Marion and R. E. Jacobson, Ohio State University and Ohio Agricultural Research and Development Center, for helpful comments and suggestions during the preparation of the article.

¹ Positions held by these men were variously titled President, Meat Merchandiser, Meat Supervisor, Head Meat Buyer, and Meat Manager, as well as Meat Director. The last term was most frequently used and is adopted throughout this article.

² Based on market share analysis provided by major metropolitan area newspapers in Ohio.

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which represent a primitive but rapidly evolving systems-approach to the problems of meat procurement, distribution, and merchandising.

A program is a plan for organized service (*a*) to retail organizations by product suppliers, or (*b*) to individual retail stores by chain or affiliated headquarters.³ Supplier-sponsored programs, offered by meat wholesalers or packers, focus on standardizing the many details of the relationship between the supplier and retail headquarters. Typical matters for standardization are product specifications, methods of price determination, advertising allowances, and various supplier services. These may be developed in response to a request from a retailer. Store programs, developed by chain or affiliated headquarters, attempt to standardize these same matters as a prerequisite to their primary concern, which is to service and/or control individual stores.

Whether employed by chains or affiliated groups, store programs vary widely in services provided. The minimum service normally provided is the central billing of meat. Programs among affiliated groups may also include centralization of store orders; central selection, advertising, and accounting; merchandising assistance; and the development of a suggested meat department price structure. Not all of these services, however, are utilized by all member retailers, some of whom cherish their independence more than the advantages that centralization can provide. But nearly all chains have at least the above services in their programs and all stores participate fully.

Newer services are being added to store programs, particularly by chains. These include warehousing, carcass streamlining,⁴ primal cutting, and preparing and packaging retail cuts. Affiliated programs are becoming more complete and enjoy improved participation by members, but generally these programs stop short of warehousing meat.

Impact of programs on the wholesale meat trade

Traditional marketing channels in the wholesale meat trade involved much individual price negotiation, purchase by inspection, packer and wholesaler delivery routes to stores, and substantial latitude for independent decision making by retail meat department managers. The growth of chain and affiliated groups, self-service, and the desire for product stan-

³ Programs have existed for many years in wholesaling and retailing dry groceries, but similar accomplishments in the marketing of perishables such as produce and meat are more recent. Processes which have reduced meat perishability allow increased efficiencies that meat programs promise and competition demands. These possibilities and demands account for much of the urgency with which meat programs are regarded by industry participants today.

⁴ Carcass streamlining procedures vary, but usually involve trimming the carcass to remove cod, kidney, and excess pelvic fat, together with the flank, plate, brisket, and shank.

darçization, has encouraged evolutionary changes such as increased use of federal grades for beef, private labels, increased direct shipments which bypass packer branch houses and independent wholesalers, and the development of chain- or affiliate-controlled warehouses which receive such shipments. Opportunities for further standardization and central control are enhanced by these changes. Meat programs represent the efforts of retailers (and also suppliers) to maximize the opportunities for improved operational efficiency that such changes present.⁵

The contrast between traditional activities and those that are described in a complete meat program are striking. Central decision making and control, facilitated by the existence of a warehouse, result in purchase by description, warehouse deliveries by suppliers (direct shipments), standardized wholesale pricing schedules (formula pricing), and the centralized store services that have been outlined. Autonomy at the store level is reduced,⁶ packer/wholesaler delivery routes diminish or disappear, and central strategies are more effectively executed by the homogenized tactics of scattered retail stores.

Control is important. It is facilitated by organizational arrangements and physical facilities, both of which are structural elements, and by centralized procurement and formula prices, which are elements of conduct.

Central warehousing and organizational structure

The primary physical ingredient in program control is the warehouse, and the existence or absence of such a facility for meat is determined in part by differences in organizational structure, such as those between chains, which own all retail outlets, and affiliates, which do not. In a chain organization, warehousing costs may be offset by savings realized at retail, and the warehouse itself may not be obliged to represent a cost saving in wholesaling activities, *per se*. But among voluntary chains, the wholesaling integrator may own few or none of the retail outlets, is not directly responsible for retail operating costs, can enjoy few if any retail cost savings in his own operation, and may thus find it more difficult to justify additional cold storage facilities for warehousing meat. Moreover, the voluntary association with member retailers denies opportunities for control that are available to chains.

Among the firms interviewed, the advantages of central warehousing were an open issue. Large chains were especially aware of advantages, particularly in increased control and aggregate cost reductions. The ma-

⁵ Pricing efficiency, however, may not be one of the goals. Rather, monopsonistic pricing is an attractive goal often sought under the guise of price standardization for improved planning.

⁶ Central policy usually attempts to minimize and sometimes to forbid sales calls by suppliers to individual stores.

Table 1. Percentage distribution of advantages of central warehousing by type of retail organization, Ohio, 1964-65

Responses to question: "Are there advantages?"	Affiliated groups	Large chains ^b	All chains	All retail firms
	percent			
No	54.5	14.2	38.4	45.8
Yes	45.5	85.8	46.2	45.8
Do not know	0.0	0.0	15.4	8.4
Total	100.0	100.0	100.0	100.0
Specific advantages cited ^a				
Continuous flow to stores when needed	16.6	11.8	11.8	13.8
Small store inventory	8.3	0.0	0.0	3.4
Fresh product on shelf	8.3	0.0	0.0	3.4
Better control	25.0	35.3	35.3	31.5
Lower costs	16.6	23.5	23.5	20.2
Better bargaining position	8.3	5.8	5.8	6.8
Make self indispensable	8.3	0.0	0.0	3.4
Only way to get national brands	8.6	0.0	0.0	3.4
Controls store delivery	0.0	17.6	17.6	10.3
Features easier to obtain	0.0	6.0	6.0	3.8
Total	100.0	100.0	100.0	100.0

^a Percentage distribution of responses for "yes" proportion in top section of table.

^b Seven large chains, each of which had 20 or more stores.

jority of affiliated groups denied that there were advantages to central warehousing, however, and among those that did cite advantages, cost and control matters, while important, were less frequently mentioned (Table 1). In consequence, affiliated organizations made substantially less use of warehouses than did chains, and most chain warehousing activity occurred among large chains (Table 2). To the extent that warehouses are in fact important elements of meat program control, successful program implementation in an operational efficiency context would be associated mostly with large chains. But program emphasis on retail pricing strategies, such as central advertising policies and control of items to be sold as "special features," frequently used by affiliates, might not be much affected by the absence of a warehouse. Responses indicated that affiliates did not associate warehouses with "special feature" control (Table 1).

Centralized procurement and formula pricing

Detailed product specifications are necessary for centralized procurement. *The National Provisioner Yellow Sheet*,⁷ together with federal

⁷ The *Yellow Sheet* is a widely used wholesale price reporting service published five days a week by *The National Provisioner* magazine, 15 West Huron Street, Chicago 60610.

Table 2. Percentage of meat volume delivered by suppliers to retail warehouses, 1964-65^a

Meat product	Affiliated groups	Large chains	All chains	All retail firms
	..... percent.....			
Carcass beef	0.0	56.2	30.1	16.0
Beef cuts	6.8 ^b	62.0	42.6	15.5
Fresh pork	0.0	31.8	17.5	10.9
Smoked pork	4.6	44.7	23.9	11.7
Fresh sausage	0.0	13.8	7.3	2.6
Veal-lamb	1.8	58.0	41.9	18.5
Broilers	9.7	44.5	24.5	18.3
Luncheon meat	2.2	8.8	15.4	12.3

^a Based on estimates provided by meat directors, frequently unsupported by reliable volume data. Figures are simple averages, therefore, without regard to variations in volume. Partial volume data suggest, however, that the striking progress in warehousing among large chains is understated in the averages for all firms in column four.

^b For example, suppliers delivered 6.8 percent of beef cuts to affiliate warehouses. The remaining 93.2 percent was delivered store-door over conventional supplier delivery routes.

grades and the USDA market news service, plays an important part in establishing specifications and prices. On the basis of information from these sources, meat directors request suppliers to submit proposals for a service program within the framework of specifications for quality, quantity, and price. Price itself is standardized in a "formula" which incorporates some constant values. For example, sophisticated formulas may include such items as standardized transportation charges, quality premiums or discounts, adjustments for weight variations, carload price differentials, and seasonal price adjustments.⁸

All 24 of the firms used formula prices in purchasing some or all of their fresh meats (Table 3).⁹ Formulas were most uniformly and widely applied in beef and pork purchases, but formula rigidity in establishing prices was most common among chains, particularly large chains. Affiliated groups frequently permitted "other considerations" to enter into their pricing decisions, and some formulas were quite flexible. But completely unstructured competitive pricing in beef or pork purchases was not the policy of any firm. Such open-market pricing did figure somewhat in

⁸ The word "formula" implies a precision that most formulas do not have. Few formulas are sophisticated enough to be precise, and even these fail to be formulas in a mathematical equation sense. Moreover, the term has become popular in the meat industry and has been adopted by some to describe customary buying procedures and might refer to nothing more than "cost plus freight." It was useful for the authors to probe interviewees for distinctions between "rigid" and "flexible" formulas.

⁹ According to estimates of the National Commission on Food Marketing, 41 percent of the beef sold in the United States by packers to their major customers in 1964-65 was priced by formula [3, p. 26].

Table 3. Percentage distribution of the methods used to determine prices paid for wholesale meat products, by type of retail organization and class of fresh meat, Ohio, 1964-65

Retail organization and meat products	Unstructured competitive pricing ^a	Rigid formula	Flexible formula ^b
Affiliated groups	<i>percent</i>		
Beef	0.0	54.5	45.4
Pork	0.0	54.5	45.5
Broilers	9.2	45.5	45.5
Veal	72.6	18.2	9.2
Lamb	72.6	18.2	9.2
Large chains^c			
Beef	0.0	100.0	0.0
Pork	0.0	100.0	0.0
Broilers	14.3	85.7	0.0
Veal	57.1	42.9	0.0
Lamb	42.9	57.1	0.0
All chains			
Beef	0.0	100.0	0.0
Pork	0.0	100.0	0.0
Broilers	15.4	84.5	0.0
Veal	61.5	38.5	0.0
Lamb	46.2	53.8	0.0
All retail firms			
Beef	0.0	79.2	20.8
Pork	0.0	79.2	20.8
Broilers	12.5	66.7	20.8
Veal	66.6	29.2	4.2
Lamb	58.3	37.5	4.2

^a Pricing without the aid or utilization of formula.

^b Perhaps involving little more than "cost plus freight" and subject to amendments and alterations in view of competitors' actions, cutout tests, store requirements, etc. May involve only "features."

broiler purchases and was common in veal and lamb purchasing.

Half the firms reported deviations from rigid formula price schedules (Table 4). Some deviations amounted to seasonal adjustments in annual average price differentials stated in some formulas. However, seasonal adjustments were explicit in the more complete formulas and thus were not regarded as deviations in those circumstances. Also, windfalls to buyers, such as packer surpluses, were exploited when the opportunity arose. Finally, irregularities such as logistic failures and unexpected tactics by competitors caused some deviations to occur.

Some Effects

Selection and dismissal of suppliers

A developing national pattern in which national packers are relatively frequent suppliers of many products to large chains, while regional pack-

Table 4. Percentage of retail organizations allowing exceptions to formula prices, Ohio, 1964-65^a

Exceptions	Affiliated groups	Large chains	All chains	All retail firms
	percent			
Irregular	0.0	0.0	8.1	4.0
Seasonal	44.9	28.9	16.3	29.1
Packer surplus ^b	8.7	28.9	21.6	16.7
None	46.4	42.2	54.0	50.2
Total	100.0	100.0	100.0	100.0

^a Based on subjective responses to open-ended interview questions. Differences in interpretation of questions resulted in responses difficult to categorize. For example, occurrences regarded by meat directors of small chains as irregular deviations from formulas could have been regarded by directors of affiliates, which applied more "flexible" formulas, as within the scope of the formula price structure.

^b Results in a lower price than formula would indicate.

ers predominate as suppliers to affiliated and independent retailers, has been widely noted [4, chap. 5; 6, pp. 101-106, 124-127]. The mutual needs of buyers and suppliers are more ably met through this arrangement, but the needs of retailers predominate, reflecting their stronger bargaining positions.¹⁰

Retailer needs and expectations for supplier performance were described by Ohio meat directors in criteria for selecting and dismissing suppliers. Differing needs of chains and affiliates were reflected in differing viewpoints on selection and dismissal standards (Tables 5 and 6). Among affiliates, for example, the most important single criterion in selecting a supplier was *dependable service* and the most common cause for dismissal was *unreliable delivery*. Among large chains nothing was more critical in selecting a supplier than *uniform quality*, and two-thirds of all dismissals occurred for *inferior or inconsistent quality* and *unreliable delivery*.

Reliable delivery and service are particularly important to affiliated wholesalers. Unreliable performance by a supplier in these matters may result in the loss of retail accounts by the wholesaler. Because their stores are captive outlets, chains are spared such consequences and place relatively more of their emphasis in supplier performance on product quality.

¹⁰ Aside from a strong structural base or the advantages of private labels, retail market power may flow from other sources: "In a chronically abundant supply situation—typical of agriculture except in wartimes—bargaining strength is enhanced by being positioned in the marketing channel closest to consumers. In addition retailers are not committed to an inventory of specific items that must be sold, as are packers. Also, attractive supplies are usually readily available from other packers. . . . Exchange practices have reflected the stronger bargaining position of buyers. When concessions or allowances are made they usually have flowed in one direction—from seller to buyer—not from buyer to seller" [4, p. 49].

Price was not a big factor causing dismissals. Some difficulties encountered by affiliates, such as high prices and overcharging, seldom created problems for chains. Another problem unique to affiliates was difficulty in enforcing policies about suppliers not selling direct to stores.¹¹

Types of suppliers

Given these standards for acceptable and unacceptable supplier performance, the comparative importance of regional and national packers as suppliers is readily explained. Viewpoints of Ohio meat directors reveal some sharp contrasts between affiliate and chain judgments of these two classes of suppliers (Tables 7 and 8). All respondents agreed that regional packers offered distinct advantages as suppliers. More than half the respondents said that they found no distinct advantage in having national packers as suppliers. Although large chains were more reserved in this latter judgment, they also supported the view that there were shortcomings in national packer performance.¹² Most of these criticisms related to

¹¹ This is an especially provocative problem. Lacking warehouses, affiliates require store-door delivery service. The supplier's truck driver frequently doubles as a salesman when he makes deliveries. Moreover, the store operator, although voluntarily associated with the wholesaler, frequently associates his welfare closely with his store and his own management ability, and solicits sales calls in defiance of affiliate policy. Sellers to individual stores include suppliers that have no contact with the wholesaler and that even may wish to avoid such contact.

¹² Chains strive for complete meat programs, standardized and impersonal, but complain when suppliers display similar behavior and seek similar objectives. A recent Ohio study showed that meat packers share similar uncomplimentary attitudes toward chains [5].

Table 5. Percentage distribution of significant factors in selecting a supplier, by type of retail organization, Ohio, 1964-65

Factors ^a	Affiliated groups	Large chains	All chains	All retail firms
	percent			
Dependable service	37.8	14.2	17.9	27.0
Lower price	16.6	16.6	10.2	13.1
Meat program	12.1	11.9	19.2	15.9
Uniform quality	22.7	30.9	19.2	20.8
Reliability, integrity	3.0	26.4	17.9	11.1
Packer cooperation	6.0	0.0	1.2	3.4
Advertising, promotion	1.8	0.0	0.0	0.6
Community image	0.0	0.0	11.5	6.2
Personal contact	0.0	0.0	2.9	1.9
Total	100.0	100.0	100.0	100.0

^a Retail meat directors were requested to list, in order of importance, three factors that they considered when they selected a supplier for a particular product. No suggestions were given to them by the interviewer. The factors were weighted 3 for the first factor mentioned, 2 for the second, and 1 for the third for the purpose of computing this distribution.

Table 6. Percentage distribution of factors significant in causing dismissal of a supplier, by type of retail organization, Ohio, 1964-65

Factors	Affiliated groups	Large chains	All chains	All retail firms
	<i>percent</i>			
Inconsistent and/or poor quality	12.5	31.2	33.3	23.5
Unreliable delivery	37.5	31.2	29.6	33.3
Failure to carry out commitment	16.6	18.7	14.8	15.6
Direct selling to stores	12.5	0.0	0.0	5.8
Misrepresentation	4.1	6.2	3.7	4.0
Poor claim service	4.1	0.0	0.0	2.0
Failure to develop specials	4.1	6.2	11.2	7.8
Overcharging	4.1	0.0	3.7	4.0
Consistent higher pricing	4.5	0.0	0.0	2.0
No consumer demand	0.0	6.5	3.7	2.0
Total	100.0	100.0	100.0	100.0

Table 7. Percentage distribution of responses on advantages and disadvantages of national packers as suppliers, by type of retail organization, Ohio, 1964-65

Answer	Affiliated groups	Large chains	All chains	All retail firms
	<i>percent</i>			
Disadvantages, total	54.5	42.8	53.8	54.1
Disadvantages, specific				
Ineffective advertising	14.2	0.0	0.0	6.6
Poor distribution systems	43.2	20.0	37.5	40.0
Weak sales force	14.2	0.0	0.0	6.6
Inconsistent and/or poor quality	14.2	20.0	12.5	13.0
No local image	14.2	0.0	12.5	13.0
Price too high	0.0	20.0	12.5	6.6
Too impersonal	0.0	40.0	25.0	14.2
Total	100.0	100.0	100.0	100.0
Advantages, total	45.5	57.2	46.2	45.9
Advantages, specific				
Universal	66.6	14.2	30.0	43.7
Wide consumer acceptance	33.4	14.2	10.0	18.7
Complete meat program	0.0	43.2	30.0	18.7
National advertising	0.0	14.2	10.0	6.2
Availability of product	0.0	14.2	10.0	6.2
Personal contacts	0.0	0.0	10.0	6.5
Total	100.0	100.0	100.0	100.0

Table 8. Percentage distribution of responses on advantages and disadvantages of regional packers as suppliers, by type of retail organization, Ohio, 1964-65

Answer	Affiliated groups	Large chains	All chains	All retail firms
	percent			
Disadvantages, total	0.0	0.0	0.0	0.0
Advantages, total	100.0	100.0	100.0	100.0
Advantages, specific				
Higher, more consistent quality	24.0	9.0	7.6	14.0
Faster and better distribution	28.0	27.0	28.2	28.1
Local image	16.0	18.0	23.0	20.3
Price	4.0	4.5	10.2	7.8
More effective advertising and promotion	28.0	22.7	20.4	23.4
Maintain minimum retail prices	0.0	4.5	2.5	1.5
Personal control	0.0	4.5	2.5	1.5
No volume requirements	0.0	9.8	5.6	3.4
Total	100.0	100.0	100.0	100.0

weaknesses in national distribution and advertising systems—weaknesses which stem from the centralization and standardization that coordination at this level requires, but which result in inflexibility at local levels. The inflexibility creates problems in terms of local advertising impact, product quality variations, poor delivery timing, sales forces unfamiliar with local demand patterns, difficulties in rectifying errors, and impersonal attitudes toward retailers' problems in these respects. To a noticeable degree, however, large chains mentioned these problems proportionately less often than did affiliates and small chains.

But the advantages of these same characteristics of national packers frequently outweighed the disadvantages. For example, affiliates were quite responsive to the consumer acceptance enjoyed by nationally known brands, which, in turn, facilitated meat program control with member retailers and contributed cohesiveness to the organization. Chains, particularly large chains, stressed cost and volume requirements and commended national packers for their capacity to respond to these needs. The advantages of regional packers as suppliers were related closely to their local flexibility and thus to their capacity to perform well those tasks which national packers were unable or unwilling to perform with equal finesse.

The activities and interests of most small chains and many affiliates are confined to relatively small geographic areas, part of a state, perhaps, or one metropolitan area. Their requirements are compatible with the inter-

ests of regional and local packers; as a result, many small chains and affiliates purchase primarily from regional and local packers but turn to national packers for supplementary advantages such as national brands.¹³ Similar compatibility causes large chains and national packers to regard local inflexibility generally as a fact of life and to establish trade channels which function well in meeting massive volume requirements of both parties. But large chains turn readily to smaller packers for added advantages such as service flexibility and locally established brand names. In each case, the buyer-seller relationship emerges as a marriage of functionally compatible partners joined in a union of mutual requirements. These relationships were apparent in supply channels used by Ohio retailers, although regional and local suppliers provided more than half the volume of most products to both chains and affiliates.

Net Effect

The impact of meat programs on operational efficiency, wholesaling methods, and trade channels is affected by the control exercised over the program.¹⁴ Centralized procurement and standardized prices facilitate this control. But the degree to which purchases may be centralized and the rigidity with which formula prices can be enforced are related to organizational structure, firm size, and physical facilities. The effect of these factors is illustrated by direct comparison of selected features of large chain and affiliated operations (Table 9).

Large chains made extensive use of central warehouses, which, for reasons which have been outlined, affiliated groups found more difficult to justify. Moreover, large chains adhered more closely to formula prices than did affiliates and enforced their price standards more rigidly.

Formula pricing requires detailed product specification. Quality, quantity, and price specifications are conducive to purchase by description, which is commonly associated with improved operational efficiency in the performance of exchange functions. Large chains generally purchased a higher percentage of supplies by description than did affiliates, particularly in beef purchases, which represented about 40 percent of retail meat sales for both types of operation. Self-service and large volume have already established chain store policies for product specification and purchase by description. Strict application of formula prices and related stan-

¹³ Many small chains and affiliates do not wish to impair the bargaining power that fortuitous circumstances such as those described in footnote 10) have given them; therefore they avoid becoming too dependent on a powerful supplier.

¹⁴ The argument is not intended to encompass strategies affecting pricing efficiency, which were not investigated.

Table 9. Selected characteristics of affiliated and large chain retailers, selected meat products, Ohio, 1964-65

Characteristic	Product class					
	Carcass beef	Fresh pork	Broilers	Veal	Lamb	Smoked hams
	<i>percent</i>					
Total deliveries to warehouse						
Affiliate	0.0	0.0	9.7	1.8		4.6 ^b
Large chains	56.2	31.8	44.5	58.0		44.7 ^b
Firms with rigid formula applications						
Affiliate	54.5 ^a	54.5	45.5	18.2	18.2	^c
Large chains	100.0 ^a	100.0	85.7	42.9	57.1	^c
Volume purchased by description						
Affiliate	29.5	^c	99.1	27.7	54.1	^c
Large chains	61.5	^c	77.2	70.0	72.9	^c
Volume supplied to affiliates by						
National packers	4.2	8.0 ^d	7.6	17.5	41.6	4.9
Regional packers	72.3	86.5 ^d	45.8	38.1	41.6	93.9
Local packers and wholesalers	23.5	5.5 ^d	46.6	44.4	5.5	1.2
Volume supplied to large chains by						
National packers	40.8	14.0 ^d	22.9	10.9	44.2	28.4
Regional packers	59.0	80.5 ^d	37.8	68.3	55.8	71.6
Local packers and wholesalers	0.2	4.5 ^d	39.3	20.8	0.0	0.0
	<i>number</i>					
Average number of suppliers						
Affiliate	4.3 ^a	4.2	3.7	2.0	2.3	8.6
Large chains	5.7 ^a	3.4	2.5	1.8	2.2	5.0
Modal days per week orders given to suppliers						
Affiliates	5 ^a	5 ^d	5	2	3	2
Large chains	1 ^a	1 ^d	2	2	2.5	1

^a All beef.^b All smoked pork.^c No data available.^d Loins only.

dards, together with central receiving facilities as an aid to enforcement, assists this established chain policy.

The meat volume of large chains typically exceeded that of affiliated groups, yet the average number of suppliers servicing chains was generally lower than the number supplying affiliates. Part of this difference can be explained by large volume and more complete product lines typical of national packers, through which large chains purchase most of their supplies. But part of it must be associated with the orderliness of procurement practices which is a principal outcome expected of an effective meat program. A measure of orderliness is the frequency with which purchase

orders are submitted to suppliers. Affiliates typically placed daily orders for major supplies such as beef, broilers, and fresh pork; large chains submitted orders once or twice a week. Affiliates placed orders with national packers for only a small percentage of total needs; large chains made frequent purchases from national packers but did not purchase from them a majority of their requirements for any product except canned hams. Nevertheless, the tendency for affiliates to seek the services of smaller suppliers contrasted with the tendency of large chains to minimize contacts with small-volume suppliers.

Some Broader Implications

Meat programs do not generate market power; they articulate the demands of a power that already exists. They are not a basis for internal control; they are created by controls already at hand. They do not create a basis for organized activity; they arrange the activities that already have an organizational framework.

Much of the enthusiasm about meat programs and much of the urgency that accompanies their development among small chains and affiliates rests on mistaken expectations that are not likely to be realized. Meat programs will not help to control member retailers as much as control of member retailers would help programs. A program may not make up for the lack of a warehouse as much as a warehouse might make up for the lack of a program.

But when viewed in the proper context, as a systems-approach to activities that already can be controlled, meat programs hold attractive possibilities for retailers. So attractive are the possibilities that incentives to achieve the prerequisite control elements probably will be a contributing factor to the growth and merger rate among small chains, to increased development by affiliated wholesalers of "company stores," which the wholesaler owns but services along with those of member retailers, and to increased levels of commitment imposed upon affiliate membership. Present meat programs among small chains and affiliates, even lacking sufficient control, or failing to represent significant power, undoubtedly aid the organizations they serve by bringing a relative degree of order to a comparative condition of chaos. But the full benefits of programs in the long run are likely to accrue to organizations with the internal structure to control them and with sufficient market power to benefit from having it expressed through a program which can be enforced.

The gradual shift in market power, over the past half-century, from meat packers to retailers has brought a growing respect for market-oriented production planning to the livestock-meat industry. Consumer-minded retailers with skill to specify and power to enforce their demands have been factors in the emergence of a functional marketing system from

a less responsive product distribution network.¹⁵ Yet the coordination of demand and supply response remains a clumsy process. The growth of meat programs suggests emphatically that remaining inefficiencies are under systematic attack. The implications of total meat program development lie not so much in the power that programs would represent as in the keen edge of purposefulness they would give to power that is already acknowledged.

An articulate expression of required product characteristics, together with an enforceable set of rewards and punishments which can be applied with discriminating precision, enormously improves the sensitivity and agility of supply response.¹⁶ The process of change, proceeding at an evolutionary pace, is greatly speeded up.

Retailer-defined product standards, together with private labels, make product differentiation increasingly difficult for meat packers. Their product is reduced closer to an undifferentiated commodity status, and the basis for negotiating a differential price is undermined while the prospects for accepting a very competitive price grow larger. Pure profit opportunities in packer selling markets are reduced. Other profit opportunities are sought in selling markets, such as the development of nonmeat product lines that are more easily differentiated and the search for less knowledgeable or less powerful buyers in less organized markets.

But much, and perhaps most, of the concern for profit in the meat packing industry is focused on cost controls and operational efficiency rather than on the less promising area of product pricing. Costs in the meat packing industry have risen steadily, and the cost of livestock and other raw materials constitutes approximately 75 percent of total costs [1, inside front cover]. Effective buying of livestock is critically important, but the job is not well done, and the barriers to getting the job done well are formidable.

Market-oriented planning is only primitively developed at the farmer-livestock market level. Consumer tastes, buyer requirements, and market demands are accorded much less consideration in decision making than are production requirements or sale methods. Markets, including those that are not farmer-owned, tend to regard themselves as guardians of producer interests. Their loyalties thus lie with their suppliers more than with their buyers, and their function in the marketing process is viewed principally as a distributive role. Well insulated by an agrarian institutional framework which extols the sovereignty of production, pro-

¹⁵ Documentation of this shift and exploration of its effects are available in agricultural marketing literature. Much of this material has been integrated and interpreted by Williams and Stout [7].

¹⁶ The term "enforceable" implies that sufficient power is available to overcome resisting power and reciprocal pressure that may be encountered.

ducers and market operators receive with alarm and resentment the news of powerful market demands that is brought to them by plaintive but determined packer buyers. Moreover, product specifications received by producers frequently are inconsistent with firmly entrenched notions of ideal type in livestock¹⁷; and retailer actions, attitudes, and beliefs seem overbearing and badly in need of correction. Finally, it is honored custom that livestock be fattened as a supplementary enterprise on Corn Belt farms, delivered in small lots to markets, and paid for immediately in live-weight prices.

The numerical majority, or perhaps merely the vocal element, in this institutional structure is inclined to resist the growing demands for market-responsive production planning. But the pressure is relentlessly applied and it is doubtful that unyielding methods can survive as profitable endeavors. Perhaps the vanguards of change already apparent in livestock production and marketing can be viewed as reliable heralds of central tendencies for the future. These include the rapid growth of commercial feedlots (sharply profit-motivated operations that are *not* supplementary enterprises and *not* dependent on Corn Belt agriculture), direct marketing from feedlot to packing plants, integrated or contracted production, and the use of carcass rather than live prices as a more accurate basis for title transfer. These developments are interrelated and collectively represent an awareness of market demands, an acknowledgment of new levels of operational and pricing efficiency thus imposed, and an effort to circumvent barriers to attainment encountered in an institutionalized production and marketing sector that is adjusting too slowly.¹⁸

¹⁷ For example, the new cutability grades for beef constitute a meaningful new basis for specification buying by assigning value to the percentage of retail-salable meat that can be cut from a beef carcass. Even at differential live prices associated with quality attributes like Choice and Prime, the cutability grades demonstrate that a low Choice steer, by quality standards, may frequently possess carcass characteristics that relate to high cutability and to retail value exceeding that of an equal carcass-weight Prime steer from the county fair circuit. This knowledge encourages astute packers to buy direct from feedlots, where they can sort cattle and choose animals with a degree of selectivity that is discouraged at many livestock markets.

¹⁸ Public service and regulatory programs which foster a healthy competitive environment also are challenged to adjust by these new developments. Farmer sellers confronting the bargaining dexterity of professional buyers in direct-to-packer sales of livestock lack many of the protections found in established marketing channels. For example, wholesale prices are readily available to and widely understood by buyers in proportions not matched on the selling side. The use of carcass weight and grade as a basis for title transfer offers advantages to both buyers and sellers but little assurance that the advantages will be equitably shared. Terms of trade specified in formal contracts use parameters that neither side can deal with knowledgeably.

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Cost and Price Effects of Concentration Restrictions in the Plant Location Problem*

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Restrictions which prevent monopolization of spatial markets are imposed on the plant location problem for agricultural processing industries. The antitrust laws are assumed to be the source of these restrictions. Restricted and unrestricted solutions for an example problem and for the fluid milk processing industry in the state of Washington are compared. The restraints are shown to alter spatial organizations in such a way as to increase industry costs, but they also reduce the latitude for spatial price discrimination which may exist in unrestricted organizations.

THE least-cost location of agricultural processing facilities within some specified geographic area has been the subject of a number of recent studies. Some of these studies have dealt with the assembly and processing of individual commodities or groups of commodities from a producing region [11, 14, 15]; others have considered distribution as well [5, 7]. At least one study has concerned itself with the location of a multiplant firm [13]. Their objective has been to determine the number, size, and location of processing plants needed to minimize combined processing and transportation costs, given information about the relevant cost functions and the geographic distribution of production and, in some cases, consumption. An assumption common to all these studies is that no institutional or structural restraints affect the degree of concentration attained by the processing industries in their prescribed area markets: costs alone affect the degree of concentration attained. The purpose of this article is to examine the effects on costs and potential prices when external limits on concentration are imposed on the location problem. Restricted and unrestricted solutions for example location problems will be compared to demonstrate these effects.

The Restricted Plant Location Model

The objective of the plant location model, as commonly stated, is to minimize the combined costs of the assembly and processing of raw product and the distribution of final product within area markets having fixed quantities of production and consumption per unit of time. The mathematical configuration of the problem for a single product is as follows:

$$(1) \quad Z = \sum_i \sum_j C_{ij} X_{ij} + \sum_j \sum_k C_{jk} X_{jk}$$

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subject to the constraints

$$\begin{aligned}
 (2) \quad & \sum_j X_{ij} = S_i \\
 (3) \quad & \sum_j X_{jk} = D_k \\
 (4) \quad & \sum_i S_i = \sum_k D_k \\
 (5) \quad & X_{ij}, X_{jk} \geq 0
 \end{aligned}$$

where

S_i is the output of raw product in producing area i ,

D_k is the consumption of final product in consuming area k ,

C_{ij} and C_{jk} are, respectively, the unit costs of assembly and processing of raw product from area i in plant j and distribution of final product to area k , and

X_{ij} and X_{jk} are the quantities assembled, processed, and distributed from area i through plant j to area k .

This model is clearly unrestricted from a structural standpoint. Nothing in the model except costs influences the ultimate spatial organization and the allocation of the spatial markets among plants. All potential plants are treated as though members of a single firm or, alternatively, all firms in the industry are assumed to coordinate their plant location and scale decisions in order to minimize industry costs. A monopolistic solution is obvious in the first alternative, where one firm makes the location decisions. Spatial monopoly may also be implied by the second alternative. The cost minimization criterion may require firms to partition the total area market among themselves, establishing firms as spatial monopolists in one or more of the individual area markets. In either case, opportunities for spatial price discrimination may result from the spatial organization determined by this model.

The structural implications of the model are changed considerably by the addition of a restriction on spatial monopoly. This restriction can be stated as follows:

$$(6) \quad X_{jk} \leq A_k < D_k.$$

Constraint (6) specifies that the quantity of final product distributed to area k by plant j cannot exceed the quantity A_k , which is less than D_k .¹ Concentration in the spatial organization of distribution will be reduced, since residual requirements in the area markets must be supplied by some other plant belonging to some other firm. The objective of this restricted

¹ It is clear that a similar constraint could be imposed on assembly. However, only restrictions on distribution will be considered here.

model remains to determine the spatial organization which minimizes industry costs consistent with the additional constraint.

Upon what basis could such restrictions logically be imposed? To answer this question, consider the situation of an agricultural processing industry which is progressing towards a concentrated spatial organization. Firms and processing plants are being eliminated through outright closure or through merger and consolidation. Market shares held by the surviving firms in individual area markets increase as industry concentration continues. This process can be thwarted if, at some point, the antitrust laws are invoked to erjoin mergers, order divestitures, or otherwise act to preserve a competitive environment in the industry by halting the growth of concentration.² Therefore, the restrictions can be viewed as institutional in nature, imposed on the industry through the mechanism of the antitrust laws.³

Constraint (6) could take the form of either a proportional restriction or an absolute restriction on the quantity distributed by processors. A combination of the two might also be imposed. Both forms have some basis in current antitrust enforcement. Market shares within specific geographic areas have been important criteria in merger cases prosecuted under Section 7 of the Clayton Act [10, pp. 264-267]. Though not tied to specific geographic areas, an absolute criterion for mergers in the dairy industry, expressed in terms of annual sales volume, was pronounced in the Beatrice Foods case [4].

Cost and Price Effects of the Restrictions

In order to alter the competitive environment in a given location problem, the constraints placed on distribution activities must change the spatial organization, compared to the unrestricted organization, in such a way as to reduce the latitude for spatial price discrimination. At the same time, deviations from the physically optimum organization must be expected to increase industry costs. These effects on costs and potential prices can be illustrated by comparing solutions under restricted and unrestricted models for a simple three-area, three-plant location problem. In both models, it is assumed initially that each plant represents an independent firm.

² The lists of cases developed by the National Commission on Food Marketing show that antitrust agencies have been active in agricultural processing industries [12]. Some of these cases, especially in dairy processing, have been concerned directly with concentration in spatial markets.

³ The provisions of the antitrust laws which are of particular concern here are (a) Section 2 of the Sherman Act, which prohibits attempts to monopolize interstate trade, (b) Section 7 of the Clayton Act, which prohibits mergers which may substantially lessen competition, and (c) Section 5 of the Federal Trade Commission Act, which deals with unfair methods of competition.

Unrestricted model

Section I of Table 1 shows the transshipment problem formulation of the unrestricted location model for the example problem. It conforms to the short-run plant location problem formulation suggested by Hurt and Tramel [6]. Submatrix *A* of this section of Table 1 shows unit costs for the assembly and processing of raw product; available supplies and processing capacities are given by the appropriate row and column totals. The diagonal elements of submatrix *C* allow for disposal of excess processing capacity at zero cost. Submatrix *D* shows unit distribution costs, with capacities and requirements given in the adjoining row and column totals. The prohibitively high unit costs in submatrix *B* and the nondiagonal elements of submatrix *C* force the commodity to flow through the appropriate marketing stages. All costs are net of production costs, which are assumed to be equal in all supply areas.

Section II of Table 1 shows the least-cost solution under the unrestricted model. Costs are minimized at 622 units. In this solution, plant 1 assembles and processes 20 units of product, meeting all requirements in market area 1. Plant 3 assembles and processes 40 units of product to meet all requirements in market areas 2 and 3. The quantities shown in parentheses in submatrix *D* of the solution are the delivered costs for each plant to each area. Prices must equal or exceed these delivered costs before plants can process and distribute to an area without loss.

The pricing implications of this solution depend not on costs alone, but also upon the number of firms represented, barriers to entry, and the elasticity of demand. Barriers to entry by new firms are assumed to be substantial. Demand has been assumed to be perfectly inelastic, although opportunities for spatial price discrimination have been demonstrated even where demand is elastic [9, pp. 147-153]. Under these assumptions, only the threat of entry into each other's markets by existing firms limits the latitude for spatial price discrimination implied by the model. Therefore, this latitude is limited only if two or more firms are represented in the solution.

Although three firms were assumed to be present initially, long-run stability will be achieved with only two firms. Inspection of the delivered costs shows that if it were not for the threat of re-entry by plant 2, plant 3 could increase prices in market areas 2 and 3 to 19 and 20 units respectively before plant 1 could enter these markets without loss. However, plant 2 could resume operations with a price of 15 in area 2 or a price of 18 in area 3. Therefore, plant 3 would find it advantageous either to adopt a pricing policy which would force plant 2 from the industry in the long run or, more realistically, to seek to eliminate it by merger or purchase. Once plant 2 is eliminated, plant 3 could raise prices in its markets up to the levels of plant 1's alternative delivered costs. Plant 1 could do likewise

Table 1. Three-area, three-plant unrestricted location problem

Section I: Matrix of costs, supplies, and requirements										Section II: Minimum-cost solution ^a										
			Plants			Consuming areas			$S_{i,j}$				Plants			Consuming areas			$S_{i,j}$	
			1	2	3	1	2	3					1	2	3	1	2	3		
Supply areas	1	A	11	17	12	B ^b	*	*	12	1	Supply areas	A	12	0	0	B	0	0	12	
	2		13	15	11		*	*	20	2			8	0	12	0	0	0	20	
	3		15	18	8		*	*	28	3			0	0	28	0	0	0	28	
Plants	1	C ^b	0	*	*	D	0	6	7	30	1	C	10	0	0	D ^c	(13)	(19)	(20)	30
	2		*	0	*		6	0	3	20	2		0	20	0	(21)	(15)	(18)	20	
	3		*	*	0		7	3	0	50	3		0	0	10	(18)	(14)	(11)	50	
$D_{j,k}$			30	20	50		20	10	30		$D_{j,k}$		30	20	50		20	10	30	

^a Costs are minimized at 622 units.^b An asterisk denotes a prohibitively high cost.^c Numbers in parentheses indicate delivered costs for alternative distribution activities.

in its market. If we assume no collusion between the two surviving firms, the upper bounds of the latitude for spatial price discrimination would be represented by prices of 18, 19, and 20 units respectively in the three markets.⁴

Restricted model

A concentration restriction is now added to the model. Processing firms are prohibited from supplying more than 70 percent of total requirements in each of the three market areas. Formally, this market share constraint is

$$(7) \quad X_{jk} \leq 0.7D_k$$

for each firm in each market.

Section I of Table 2 shows the transshipment problem formulation of the restricted location model. Costs, supplies, and requirements remain the same as before. Submatrices *A*, *B*, and *C* are also the same. Submatrix *D*, however, is quite different from the conventional formulation shown in Table 1. In addition to the usual limitations imposed by row and column totals, activity levels in this submatrix are restricted internally by upper bounds which express the market share constraint in terms of maximum distribution quantities. These upper bounds specify that no one plant can distribute more than 14 units of final product in market area 1, 7 units in area 2, and 21 units in area 3. Transshipment models containing variables with upper bounds are known as *capacitated transshipment problems*. Dantzig has provided a simplex solution procedure for this class of problem [3, pp. 368-380]. This procedure has been used to obtain the solution shown in Section II of Table 2.

The number and size distribution of processing plants is altered by the imposition of the market share constraint on the example problem. All three plants operate in the restricted solution, and assembly, processing, and distribution activities are changed accordingly. The model allocates the maximum permissible market share in each market area to the plants having the lowest delivered costs. Residual shares are allocated to the plant having the next lowest delivered costs. The restricted solution is clearly less efficient from a physical standpoint than the unrestricted solution. Costs are minimized at 718 units, 96 units more than in the unrestricted solution.⁵

⁴ In game theory terminology, these prices represent a noncooperative equilibrium point for the duopolistic organization. At lower prices, the maximin strategy for each plant is to increase prices in its own markets and avoid penetration into its rival's markets. At higher prices, the maximin strategy for both firms is to reduce prices and seek to enter each other's markets.

⁵ The cost differential measured here is at a minimum since firms are assumed to act in such a way as to minimize industry costs. If this assumption is relaxed, the cost

Table 2. Three-area, three-plant restricted location problem

Section I: Matrix of costs, supplies, requirements, and restrictions										Section II: Minimum-cost solution ^a												
			Plants			Consuming areas			$S_{i,j}$				Plants			Consuming areas			$S_{i,j}$			
			1	2	3	1	2	3					1	2	3	1	2	3				
Supply areas	1	A	11	17	12	B^b	*	*	*	12	Supply areas	1	A	12	0	0	B	0	0	0	12	
	2		13	15	11		*	*	*	20		2		2	12	6		0	0	0	20	
	3		15	18	8		*	*	*	28		3		3	0	0		28	0	0	0	28
Plants	1	C^b	0	*	*	D^c	≤ 14	≤ 7	≤ 21	30	Plants	1	C	16	0	0	D^d	(13)	(19)	(20)	30	
	2		*	0	*		≤ 14	≤ 7	≤ 21	20		2		0	8	0		0	(21)	(15)	(18)	20
	3		*	*	0		≤ 14	≤ 7	≤ 21	50		3		0	0	16		(18)	(14)	(11)	50	
$D_{j,k}$			30	20	50		20	10	30		$D_{j,k}$			30	20	50		20	10	30		

^a Costs are minimized at 718 units.^b An asterisk denotes a prohibitively high cost.^c Inequalities represent internal restrictions on activities.^d Numbers in parentheses indicate delivered costs for alternative distribution activities.

The latitude for spatial price discrimination is much reduced in the restricted solution, since every plant faces a present rival in each of its area markets. Any increase in price in an area on the part of one plant, unless followed by its rival, would lead to a loss of sales and revenue to the rival plant. The higher-cost plant distributing to an area could seek to increase its market share by price reductions but could not pursue this policy beyond the level of its own delivered costs without incurring losses. The prohibition against extending its market share beyond the constraint level deters the lower-cost plant from reducing prices below the level of its rival's delivered costs. Therefore, if we assume no collusive arrangements such as price leadership, prices in the restricted solution would tend to be stable at the level of the residual distributors' delivered costs. These prices would be 18 units in market area 1, 15 units in area 2, and 18 units in area 3. Thus, while industry costs are higher in the restricted solution, implied prices are equal to or less than the prices implied by the unrestricted solution.

The structural effect of the concentration restraint is further illustrated by considering the effect of mergers on the solution shown in Table 2. Since feasible solutions to the restricted location problem require at least two firms in the industry, a merger of all three firms clearly would be opposed by the antitrust agency regulating the industry. On the other hand, feasible solutions could be found if two of the firms merged. One such combination, between plants 1 and 2, would leave the solution of Table 2 unchanged. This case resembles the situation where a firm (plant 1) extends itself into new geographic markets by acquiring a firm (plant 2) already present in those markets.⁶ Other possible mergers, between plants 1 and 3 or between plants 2 and 3, would require changes in the solution which would increase both costs and prices. Whether or not the antitrust agency regulating the industry would oppose any of these possible mergers would depend on policy considerations beyond those embodied in the concentration restraint.

An Empirical Application

Restricted and unrestricted plant location models were applied to determine potential organizations of the fluid milk processing industry in the state of Washington [1]. A closed model of the state's fluid milk industry was assumed, with each of the state's 39 counties treated as a relevant

differential will become larger, relative to the unrestricted solution, as firms deviate from the locations and outputs shown in the restricted solution. Industry cost minimization is a crucial assumption to the determinacy of costs in both restricted and unrestricted plant location models.

⁶ The Beatrice Foods case is a recent example of antitrust opposition to this type of merger [4].

production and consumption area. Assembly and distribution cost functions were linear with respect to volume, but economies of scale were present in the processing cost function. The processing cost function used was similar to those used by Cobia and Babb [2]. Dairy manufacturing was assumed to be supplementary to fluid utilization; all milk not assembled for fluid use was assumed to be available for manufacturing purposes.

A combination of proportional and absolute restraints on distribution activities was imposed in the restricted model. This combined restraint was

$$(8) \quad X_{jk} \leq 0.7 D_k \leq 2,982,$$

with quantities measured in hundredweights per day. The proportional restriction applied in all market areas. The absolute restriction applied only to metropolitan areas, forcing more plants to distribute in those markets. It was imposed on the assumption that antitrust agencies would tend to take a more critical view of competitive conditions in metropolitan areas than in less populous ones.

Since the restricted model may call for more than one plant per area, the initial array of processing plants included all plants licensed to operate in the state. This array allowed for multiples of plants in the denser production areas and the more populous consumption areas. Although several multiplant firms were included in this array, the geographic dispersion of their plants seemed great enough not to impair the assumption of independent plants.

A two-step computational procedure was used to accommodate the capacitated distribution activities in the restricted model.⁷ Capacitated requirements were allocated among plants in the first step, with residual requirements carried as slack vectors.⁸ Residual requirements were then allocated in the second step. The nonlinear processing cost function was handled by means of an iterative technique similar to the method used by King and Logan [7]. Processing costs and capacities were adjusted after each iteration until, in the least-cost solution, capacities were consistent with quantities processed. The same procedure was followed to obtain the solution for the unrestricted model.

The least-cost spatial organization under the unrestricted model included only two plants, as compared with seven plants in the restricted solution. Since total industry volume remained unchanged, plants were generally smaller in the restricted solution, and total costs were approximately \$10,600 per day more than in the unrestricted solution. Although

⁷ An alternative method of reformulating capacitated transshipment models is suggested by Dantzig [3, p. 380].

⁸ For an explanation of the use of slack vectors to accommodate inequality restraints in transshipment models, see Leach and Martin [8].

the latitude for spatial price discrimination was found to be reduced by the constraints, these gains were outweighed by the loss in efficiencies of scale in processing. Under the cost functions and concentration restrictions assumed, price levels implied by the restricted solution were everywhere greater than in the unrestricted solution.

Concluding Remarks

Minimization of costs in the organization of an agricultural processing industry within a spatial market does not necessarily imply that prices will also be minimized. Prices will be influenced not only by costs but also by the latitude for spatial price discrimination inherent in the organization. The introduction of restrictions on concentration into the location problem provides a means by which relative changes in industry costs and potential pricing patterns can be compared. The procedure would appear to be useful in examining questions of spatial competition in the context of a trade-off between physical efficiency and potential spatial price discrimination.

The usefulness of both the restricted and the unrestricted plant location models as predictive devices would appear to be limited by their focus on costs. Both models assume that firms will make their location and output decisions in such a way as to minimize industry costs. Firms are much more likely to base these decisions on profit-maximizing criteria than on cost-minimizing ones. As these criteria deviate from one another, actual spatial organizations will differ from those predicted by the models, and the models will underestimate realized industry costs.

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Effectiveness of Pricing in an Indian Wheat Market: A Case Study of Khanna, Punjab*

RALPH W. CUMMINGS, JR.

An important issue in food grain marketing in India concerns the effectiveness of competition, but there is little empirical research on which to evaluate the issue. This article analyzes pricing effectiveness in one private wholesale wheat market in north India by comparing average seasonal and spatial price differences with estimated storage and transport costs. The comparisons indicate that correspondence between average price movements and average cost differences was reasonably close.

REPEATED criticisms of the private food grain trade in India have focused on two charges: (a) that middlemen create artificial pockets of scarcity and earn monopoly profits by selling their own food grains in these isolated markets, and (b) that "speculators" cause wide seasonal price fluctuations through "antisocial" storage operations. One popular solution for these alleged abuses is to nationalize at least the wholesale portion of the food grain trade.

This article has two main purposes. The first is to present some additional evidence which is relevant to the issues involved in the above charges. In spite of the importance of the charges, there are only a few empirical studies of the economics of current agricultural marketing in India.¹ The second is to demonstrate what can be learned from a micro study of the individual market.² Price analysis using secondary data has many pitfalls, and many of the necessary data are not available in the desired form. Much useful information is available from individual markets. Micro studies can lay the groundwork for future comprehensive research on a more aggregated level.

Collection and Quality of Data

Khanna, Punjab, is one of a limited number of markets which play the important role of procuring wheat from cultivators and distributing it to consumers in other areas of India where it is not locally available. As such, it is a key to the all-India distribution of wheat.

Khanna is located in the heart of the wheat-producing region about 165

* This study is based in part on my Ph.D. thesis [2]. I did 11 months of field research in India during 1963-64. Grants under the Fulbright-Hays Act, the University of Michigan, the Ford Foundation, and the University of Illinois have supported my research. A revised version of part of the thesis was published in India [1]. Several people criticized an earlier draft of the manuscript for this article. John W. Mellor, and the reviewers and editor of the AJAE have been particularly helpful with the

miles (by road) northwest of Delhi. It ranks as one of the largest arrivals markets (35,000 tons of wheat in 1962-63). Over 90 percent of this wheat is shipped out to other markets. The major rail and road routes of the area pass through Khanna. Market operations are regulated under the Punjab Agricultural Markets Act, market data are conscientiously recorded, and officials and traders were cooperative.

Four categories of data were available in the market: (a) volumes of arrivals, (b) volumes of dispatches, (c) volumes of stocks, and (d) wholesale prices.

Arrivals are synonymous with sales; the amount of wheat delivered, but unsold, is not recorded until it is sold. A Market Committee fee is assessed on arrivals, and penalties can be levied for false reporting.

Total *dispatches* are amounts sent out of the market. However, these data reflect intentions rather than immediate actions. Independent data on specific number and destination of shipments are available for shipments by rail but not for shipments by road.

Stocks are calculated as the differences between arrivals and dispatches, accumulated over the course of time. This series is available from August 1960 only.

The *wholesale price* for each month is the modal price for the last Friday of that month. It is the price paid directly to the cultivator at open auction. Each transaction is noted. From these, high, low, and modal prices, each representing transactions of acceptable quality, are recorded for two types of wheat. The daily spread between high and low prices averaged (unweighted by volume) Rs.1.71 per quintal for *dara* wheat and Rs.3.47 for *fine* wheat over the period of the study (\pm approximately 2 and 4 percent, respectively, of the modal price).² The wheat is not graded by government standards.

There does not appear to be any systematic bias in volume of arrivals on Friday as compared with other days. However, there is considerable random variability in day-to-day and week-to-week price changes. For example, during the six years for which data were available, changes in

final drafts. Only I am responsible for any mistakes in fact or interpretation in this version, however.

¹ On food grains, see Lele [8], who includes a chapter reviewing the relevant literature on marketing in India. See also Lele's *Journal* article [9] and Kahlon [6]. Two studies of marketing of "cash" crops are by Hirsch [3] and Kulkarni [7]. Also see Jasdanwalla [5] and Neale *et al.* [10].

² For example, I disagree with Neale's conclusion that "attacks on the problem of seasonal variation in price and its significance should start not with market studies such as this one, but rather with analyses of national stocks, national distribution patterns, and costs of storage" [10, p. 151].

³ One quintal equals 220.46 lbs. One rupee (Re. 1) equals \$0.133 and 100 naye paise (nP) equal one rupee. (At the time the study was undertaken, Re. 1 equalled \$0.21).

modal prices from one Friday to the next exceeded Re.1.00 per quintal almost one-third of the time. This variability is greatest during the winter, when small arrivals and insect infestation reduce the quotable volumes to very small amounts.

Prices in other markets are reported on the one type of wheat most commonly sold in that market. However, local growing conditions and representative qualities differ from market to market. This is particularly a problem during the off-season, when volumes of arrivals decrease, quotations are based on small volumes, and quality varies. For these reasons, price comparisons of wheat reported to be of the same type (for example, *dara*) in different markets are not as straightforward as might at first appear.

Operation of the Market

From 1957 to 1961 and from 1964 to the present (March 1967), government food grain zones, restricting private interstate shipments of wheat, were in effect. This study focuses on operation during the unzoned periods (when more normal production conditions existed); data for zoned periods are occasionally introduced for purposes of contrast.

Pattern of activity

Approximately 40 to 50 percent of the wheat produced in the immediate Khanna marketing area is eventually marketed. Almost all of this wheat is delivered directly to the wholesale market by cultivators themselves [4]. Figure 1 gives four-week volumes of arrivals, dispatches, and stocks for the three-year period 1961-1964.

Arrivals follow a seasonal pattern. Marketing of the new crop begins in late April and reaches a peak volume in May and June. By the end of June, 60 to 70 percent of eventual arrivals have been marketed. The monsoon causes a noticeable decrease in arrivals during July, August, and September. During October and November, the producer markets his summer (*kharif*) harvest and sows the next year's wheat crop. Wheat arrivals are small during the remainder of the marketing year, although there is sometimes increased activity in March and early April, when the remainder of the old wheat is sold and storage is cleared to make room for the next harvest.

Dispatches lag behind arrivals during the peak marketing period. Stocks accumulate up through July; from this peak, stocks are worked down. Rail dispatches indicate that shipments go from Khanna to practically every state in India. Stocks in the hands of traders from the previous year appear to be completely gone by the time the following harvest is marketed.

The lowest seasonal wheat prices occur during the peak marketing

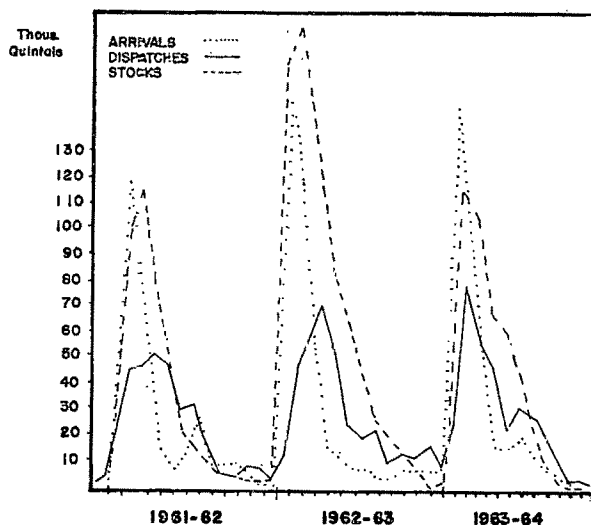


Figure 1. Volumes of arrivals, dispatches, and stocks of wheat by four-week periods in the Khanna market, 1961-62 through 1963-64

Source: Market Committee, Khanna, Punjab

months of May and June. Prices hold fairly steady through September and then rise through January or February.⁴

Decision-making process

Since 80 to 90 percent of the quantity of wheat eventually marketed arrives during the first five months after harvest, the basic purchasing decisions for the whole year must be projected before or during this time, most especially by May or June.

The resident trader's first preference is to purchase wheat on commission for nonresident buyers.⁵ The resident trader spends up to two months during the preharvest period soliciting purchase orders from markets in other states. As the season progresses, continuing written, verbal, and per-

⁴ Seasonal factors calculated by the method of ratio to centered 12-month moving average for 1959-1964 were as follows (June = 100): April 102.7, May 100.8, July 100.3, August 100.2, September 100.5, October 104.8, November 106.8, December 107.0, January 112.2, February 111.0, and March 102.9.

⁵ There are two types of traders in the market. The resident trader is called *pucca arhatya*. Producers' selling agents (*kutchra arhatyas*) are more numerous. They auction and keep books for the producers but generally make only minor purchases, most often when the bid price is unsatisfactory to the producer. Their incomes come mainly from a commission on the price paid by the buyer. The commission is standard and is set by the Punjab government. Although they do perform an important communications and service function with the producers and provide potential competition to the resident traders, the operations of producers' selling agents (as such) are not considered specifically in this article.

sonal communications connect Khanna with other markets and buyers. Orders are telegraphed or mailed to Khanna and are filled if they are competitive; if not, the bidder is advised to resubmit his order at a higher price. On the average, from 1959 to 1964, about 70 percent of the annual total of arrivals (excluding purchases by the government) appear to have been purchased directly on commission orders.

The resident trader also purchases some wheat on his own account for three primary reasons: (a) To provide for local consumption in Khanna, an assured market of 5 to 10 percent of total arrivals. (b) To hold against future needs. He must anticipate certain periods (for example, the monsoon) when commission orders will exceed arrivals. He may also store wheat on his own account to be sold later when the seasonal price rise yields a satisfactory margin. (c) To sell on consignment in Delhi or other nearby consuming centers.

For the immediate postharvest period, the resident trader has reliable information both for his local market area and for the rest of India on (a) wheat production and (b) market arrivals during the current period. Commission orders have been canvassed by his preharvest solicitations and should coincide with his expectations over the next five months. Changes in the composition of demand, indicated by changes in destination of shipment or by changes in identification of buyer, are usually offsetting.

The resident trader is less certain of projecting the supply and demand conditions for the winter months. The full effect of the monsoon cannot be measured until August or September (at the end of the peak wheat marketing period). As a result, he begins to have reasonably reliable information on summer (*kharif*) crop output only by September or October. At this late date, he can only guess the pace and pattern of *kharif* crop marketings and the wheat production for the following year. The government releases of PL 480 wheat for public consumption are unpredictable. Other exogenous factors, such as imperfect market information (most often when stocks are low during the winter), transportation difficulties, or market speculation about government policy, exert occasional price influences.

Finally, because of the insects and humidity in India, wheat is a perishable commodity. Year-old wheat is not commercially competitive with the new crop. Traders' stocks usually must be disposed of before the new harvest appears—even if the seasonal price rise is not sufficient to cover costs.⁶ The trader's ability to stock for the following year is influenced by his financial success (or lack thereof) in seasonal storage.

⁶ Information on carry-over stocks is scarce. Market Committee records indicate that traders' stocks are completely depleted at the end of each marketing year. One is less certain that stocks held on farms are depleted; the risk of poor harvest pro-

Intermarket and intramarket competition provides a constant check on these operations. Both the producers and the ultimate buyers look for the best deal they can find. In order to bring these parties together, the eight to ten large resident traders compete among themselves and with the 90 to 100 producers' selling agents who make occasional purchases in the market when prices are attractive, as well as with traders in other markets. The Khanna traders (particularly with regard to wheat) appear to be independent business units. They do not appear to be affiliated with other trading or grain-handling interests, either in Khanna market or elsewhere. Entry into the business of resident trader is relatively easy, with skills of the trade providing more of a barrier than finance. Transportation shortages and intermarket communication difficulties pose occasional problems, but these are areas somewhat outside control of the traders. My inquiries and subsequent analysis uncovered no evidence of collusion to control wheat prices either within this market or with other markets.

Influence of Market Operations on Pricing

Profitability guides the distribution of the marketed supply to meet the demands of different markets at different times of the year. In a competitive market, traders will move wheat over space if the difference in prices between two markets equals or exceeds transportation costs (including a return for the distributor) and will move wheat over time if the expected difference in prices between harvest and the time when the wheat is to be consumed equals or exceeds storage costs. In this process, competitive movements tend to narrow the differences in spatial and temporal prices to a minimum economic profit margin. Presumably, at this margin, spatial price differences would equal (or, on average, would not exceed) transport costs, and seasonal price differences from harvest would equal (or, on average, would not exceed) storage costs. The analytical task is to determine whether, in fact, these conditions are satisfied. Therefore, the analysis of prices gives an indication of the effectiveness of the physical distribution.

Relationship of Khanna prices to Delhi prices

Figure 2 shows the monthly prices in Khanna and in Delhi, the latter a major consuming market and price leader in north India. A price premium in Delhi can be turned into profit either by selling Khanna wheat on consignment in Delhi or by shifting purchases from Delhi to Khanna.

The price in Delhi must be a minimum of Rs.4.00 per quintal above Khanna prices before it is profitable for the Khanna trader to sell wheat

vides some incentive to carry over stocks. Observations of the wheat brought to market by producers during the final months of the marketing period suggest that there is substantial deterioration caused by insects as well as by humidity.

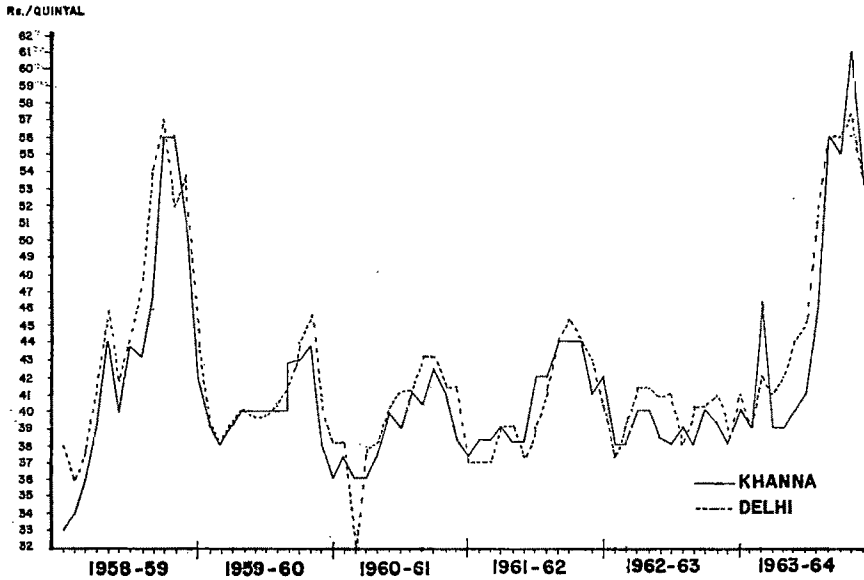


Figure 2. Delhi and Khanna monthly wholesale wheat prices, 1958-59 through 1963-64

on consignment in Delhi. Fixed charges, irrespective of the distance or destination, approximate Rs.2.00 per quintal.⁷ If the wheat is stored, rent and additional labor charges plus waste must be calculated.⁸ The railway wagon rate to Delhi was Rs.1.19 per bag (95 kilos); the truck hauling rate was Rs.2.50 per bag. On occasion, market price differences open up rapidly. Trucks require smaller minimum loads and can deliver wheat at short notice directly to the market. For these reasons, most shipments for consignment sales are made by truck rather than by rail.

The direct costs of diverting orders by importers from Delhi to Khanna were somewhat lower. The largest costs would be for communications and rail shipment to Delhi. Market fees and agents' commissions would be about the same in each market, and labor and storage charges would, if anything, be lower in Khanna. Therefore, if the traders have good information about the two markets, these extra costs need not cause prices to differ in the two markets more than Rs.1.50 to Rs.2.00 per quintal. However, except during the peak marketing period, a wagon-load takes several days to assemble, and therefore, in practice, the risk from chang-

⁷ This includes 8 nP labor charges for filling and sewing bags, 20 nP labor charges for loading and unloading trucks, 75 nP commission to the producers' selling agent, 20 nP Market Committee fee, and 75 nP sales tax.

⁸ Rent is 4 nP per bag per month and the additional labor charges would total 36 nP per bag.

ing prices influences the importer to await larger price differences than Rs.1.50–2.00 before diverting orders.

A comparison of monthly prices in Khanna and Delhi over the 1958–1964 period shows that price differences were consistently lower than transport costs. The average price difference during the six-year period was Rs.0.88 per quintal. Eighty-two percent (59 of 72) of the monthly price differences were less than Rs.2.99 per quintal. The price differences exceeded Rs.4.00 only six times (each of these times, Delhi prices led those of Khanna in adjusting to a new level).

An examination of weekly prices indicates that price differences were greater than transportation costs for short periods; wheat was probably moved from Khanna to Delhi during these periods. The large price differences did not persist.

Relationship of Khanna prices to other market prices

Table 1 gives correlations between monthly wheat prices in Khanna, in Delhi, in five other Punjab markets, and in two U.P. markets. These correlations indicate the strength of the market interdependence more generally.⁹

First, with few exceptions, the price correlations (r) are above 0.90.¹⁰ Khanna prices were most closely associated with prices for those markets located nearest to Khanna,¹¹ those quoting prices for the same type of wheat as Khanna (and competing directly for outside sales),¹² and those buying wheat from Khanna.¹³

⁹ Some work was done at an early stage, using first differences and weekly prices. However, neither of these modifications appeared to add to this analysis, for the following reasons: (a) We wish to know whether reported prices stay within transportation costs; they may move in an opposite direction due to local conditions as long as the price difference does not exceed this limit. (b) The monthly data were sensitive in evaluating this; for a large group of markets, r varied from 0.97 (between Chandausi and Hapur, U.P.) to -0.03 (between Indore, M.P., and Bombay) for the unzoned period. (c) The price lead from one market (for example, from Delhi to Khanna) is more probably a couple of days rather than a week. (d) Weekly prices are published for only a limited number of markets; reliable daily prices must be collected directly from the market.

¹⁰ An r of 1.0 would indicate that fluctuations in prices in two markets were perfectly correlated. In fact, in an effectively integrated market, prices could be expected to be correlated only within limits set by the costs of transporting wheat from one market to another. Therefore, an r of 0.90 indicates a high degree of inter-market relationship (that is, 80 percent of the variance in price in one market was associated with that in the other; the remainder of the variance stemmed from transportation and information as well as from data difficulties).

¹¹ Markets closest to Khanna are Ludhiana, Barnala, and Patiala.

¹² All other Punjab markets quote *dara* (average) quality wheat, as do the U.P. markets (although Punjab *dara* is not strictly the same as U.P. *dara*). Correlations of Khanna *dara* wheat prices with other market prices were consistently higher than were those of Khanna *fine* wheat prices. A comprehensive analysis of prices in 27 wholesale markets in seven states illustrates the observation more generally [1].

¹³ Markets which buy wheat from Khanna are Hapur, Delhi, and Agra.

Table 1. Correlation matrix of monthly wheat market prices, and average price per quintal, unzoned period, 1961-1964^a

Market	Punjab								Rs. per quintal, average price
	Khanna		Abohar	Ludhiana	Barnala	Patiala	Karnal ^b	Delhi	
	U.P.								
	Dara	Fine								Hapur	Agra
Khanna	—	0.95	0.93	0.95	0.98	0.97	0.92	0.95	41.83
Dara	—	—	0.86	0.89	0.93	0.94	0.89	0.91	47.40
Fine			—	0.95	0.94	0.93	0.89	0.90	42.17
Abohar				—	0.98	0.96	0.91	0.92	43.18
Ludhiana					—	0.98	0.94	0.96	43.79
Barnala						—	0.91	0.93	44.09
Patiala							—	0.91	42.81
Karnal								—	42.51
Delhi									42.75
Hapur								—	44.03
Agra									—

^a Prices for two types of wheat, *fine* and *dara*, are quoted in Khanna. The other market prices quote only *dara* (common) types. *Dara* is a trader designation; there was no government grading in these markets during this period. *Fine* wheat is of more uniform and higher quality than *dara* wheat, however.

^b Since the partition in 1967, Karnal has been in Haryana, but at the time of the study it was still in Punjab.

Second, the best transportation network (especially the rail connections) radiates from Delhi. Consequently, markets which are located near Delhi and hence incur lower transportation costs for delivering wheat to Delhi were found to have higher market prices than those located farther from Delhi.¹⁴ The price differences among these markets are consistently lower than the costs of transporting wheat from one market to the other.

The role of private wheat flows in bringing about this spatial price integration is demonstrated by examination of the effects of the one significant change in market structure which interfered with these flows during the period. From 1957 to 1961, government-imposed zones limited private movement of Khanna wheat to other markets in Punjab, Himachal Pradesh, and Delhi; only government-procured wheat was shipped outside the zone (and in response to government directives rather than to price differences). Table 2 illustrates the effects of this policy on market integration when it is compared with Table 1.

First, price correlations in the zoned period were high between Khanna and other Punjab and Delhi markets (which were in the same zone) but were lower between Khanna and out-of-zone markets (Hapur and Agra in U.P.) than in the unzoned period.

Second, the restricted export demand for Punjab wheat suppressed average prices in all Punjab markets (the Punjab being a wheat-surplus state). Because private shipments in U.P. were restricted (and therefore supply was further limited in this wheat-deficit state) average prices in all U.P. markets were higher during the zoned period than during the unzoned period. The difference of Rs.2.26 per quintal in average prices between the low-priced (Khanna) market and the highest-priced alternative market (Patiala) during the unzoned period contrasts with a difference of Rs.11.24 between the new low-priced (Karnal) and high-priced (Hapur) markets when zones were in effect. The latter two markets are located only 120 miles apart.

Third, within the Khanna market, the zoning had a predictable differential price effect by quality of wheat. The primary demand for *fine* wheat (as compared to the *dara* type) lies outside the zone; when zones were imposed, the price of *fine* wheat in Khanna was lower in relation to *dara* wheat than in the unzoned period.

¹⁴ Several factors complicate the analysis: (a) Different qualities or varieties of wheat are common at different markets. (b) There are only a few "best" routes for moving wheat, and these may not always go straight to Delhi. (c) Scattered throughout Punjab between exporting markets are several consuming markets, such as Ludhiana and Jullundur, which must import some of their needs from exporting markets and hence interrupt the continuous flows of wheat to Delhi. However, examination of the prices for the markets given in Table 1 suggests a rather clear spatial pattern.

Table 2. Correlation matrix of monthly wheat market prices, and average price per quintal, zoned period, 1958-1961^a

Market	Punjab							U.P.		Rs. per quintal, average price
	Khanna		Abohar	Ludhiana	Barnala	Patiala	Karnal ^b	Delhi	Hapur	Agra
	Dara	Fine								
Khanna	—	0.96	0.92	0.97	0.96	0.95	0.89	0.93	0.74	0.78
Dara			0.90	0.95	0.91	0.95	0.88	0.90	0.73	0.72
Fine			—	0.91	0.93	0.91	0.82	0.93	0.71	0.71
Abohar				—	0.96	0.91	0.83	0.91	0.68	0.74
Ludhiana					—	0.90	0.93	0.94	0.74	0.79
Barnala						—	0.93	0.90	0.77	0.76
Patiala							—	0.85	0.73	0.77
Karnal								—	0.78	0.90
Delhi									—	0.76
Hapur										0.90
Agra										—
										40.79
										43.32
										40.87
										42.77
										41.03
										43.50
										40.19
										42.00
										51.43
										49.74

^a See footnote *a* to Table 1.^b See footnote *b* to Table 1.

Relationship of seasonal prices to holding costs¹⁵

To permit comparison of actual prices with a "normal" seasonal price rise, a simple model of storage costs was calculated. Stocks are accumulated in May and June and the peak volume of stocks occurs annually in late June to mid-July. Shipments during December through March are supplied primarily from storage. Using the June price (June is the low-price month of the year and by then about 70 percent of eventual marketings have arrived) as a base, we can express the "normal" seasonal price rise through the end of the season (by which time all old commercial wheat appears to be sold) as a function of the charges for rent, extra labor, bag loss, and deterioration. Data on storage costs for six- through nine-month holding periods and actual price increases for June to December through March are given in Table 3 for each of the five years for which price and stock data were available. For purposes of this comparison, interest is excluded.

Using conservative cost figures, I found that the weighted average return for holding wheat during the five-year period, adjusted to a yearly basis, was 13.86 percent. Since the interest rate for short-term loans to reliable resident traders with collateral is approximately 9 percent per year, this leaves about 5 percent per year return for management, services, profit, and risk.

There are three months of key interest to the seasonal holder of wheat: (a) the low-priced month when he will purchase wheat, (b) the month when he will get his greatest profit from selling wheat, and (c) the last month in which he can sell his stored wheat without a loss. In the Khanna market, the trader has a high degree of certainty that the low-priced month will be May or June. Similarly, he has a fair degree of certainty that the high-priced month will be about February. However, there is little certainty that the seasonal price rise will always cover storage costs for any given storage period.¹⁶

¹⁵ The conventional seasonal price analysis is reviewed in Venkataramanan [11]. Analysis of Indian wheat prices is made especially difficult by three complications: (a) there is no formal futures market, (b) reliable information on private storage is almost nonexistent, and (c) the costs of uncertainty are especially great since there are not adequate stocks to cover emergencies—the threat of starvation is real and consumers react rapidly to shortage threats.

¹⁶ The costs in Table 3 (plus interest at 9 percent yearly), added to an average June price of Rs.38.00 per quintal, give a "normal" rise (June = 100) as follows: July 103.7, August 105.1, September 106.4, October 107.8, November 109.1, December 110.5, January 111.8, and February 113.2. Comparison of the seasonal factors reported in footnote 4 with a "normal" season price model shows that the average seasonal price rise is well below the model through September; however, it gradually approaches the norm from October through December; and actual seasonal prices are close to the "normal" during January and February on the average. At least two qualifications should be noted in these comparisons: (a) the seasonal factors are influenced by the period chosen. For the 1958-1964 period, seasonal factors rose as high

Table 3. Estimated realized net return to storage in the Khanna market, 1959-1960 through 1963-1964

Prices of wheat					
Year	June	December	January	February	March
	<i>Rs. per quintal</i>				
1959-60	38.18	39.52	42.87	43.54	38.18
1960-61	36.17	40.50	42.50	41.00	38.50
1961-62	38.50	44.00	44.00	44.00	41.00
1962-63	38.00	38.00	40.00	39.50	38.00
1963-64	39.00	56.00	55.00	61.00	53.50

Costs of holding wheat

Cost items	From June to			
	December	January	February	March
	<i>Rs. per quintal</i>			
Rent ^a	0.24	0.28	0.32	0.36
Extra labor ^b	0.32	0.32	0.32	0.32
Bag loss ^c	0.40	0.40	0.40	0.40
Deterioration ^d	1.33	1.52	1.71	1.90
Total	2.29	2.52	2.75	2.98

Changes in stocks

Year	Stocks at beginning of December	Changes during			
		December	January	February	March
		<i>quintals</i>			
1959-60	3,312	1,313	n.c.	851	91
1960-61	1,984	73	1,094	540	155
1961-62	9,037	^{ee}	^{ee}	8,271	1,402
1962-63	27,832	5,620	9,704	6,702	5,529
1963-64	10,657	9,664	799	103	91
		16,670	11,597	16,467	7,268

Net returns^f

Weighted average six to nine months	December	January	February	March
	<i>percent</i>			
13.86	39.4	4.4	6.4	-12.0

^a 4 nP per month.^b 32 nP for hauling to and from storage.^c 40 nP.^d 0.5 percent per month, beginning with 1 percent for July and going through 5 percent for March.^e Means that stocks increased slightly.^f Price change minus holding costs, weighted by volume of stock change, adjusted to yearly rate by multiplying 6-months holdings by 2, 7-months holdings by 1.71, etc., expressed as percentage of June price.

Net returns for holding periods in the different years varied from a loss of almost 8 percent for nine months' holding in March 1960 and in March 1963, to a positive return of almost 50 percent for eight months' holding in February 1964. With the single exception of December 1963, the months of large positive returns reflected small changes in stocks. In view of the fact that net returns did not consistently cover interest costs, the price risk involved in holding wheat appears to be substantial.¹⁷

Concluding Comments

This study has shown that during unmonitored periods, Khanna is competitively integrated into the larger India wheat market. Through examination of the process by a micro study at the individual-market level, it is shown how the traders bring about spatial and temporal price integration and how far the market information may be relied on to analyze the underlying economic behavior.

The Khanna trader is out to make profits. However, it appears that Khanna prices are strongly influenced by other markets; local supply and demand factors as indicated by the monthly volumes of arrivals, dispatches, and the level of stocks appear to have little independent influence.¹⁸ Although Khanna traders may be able to profit from seasonal price changes if they guess correctly, these traders do not appear to be able independently to influence seasonal prices. Nor do they appear to have been more than moderately successful in anticipating seasonal movements. These facts suggest that the constructive task of government is to improve information and transportation linkages and to provide some consistency in policy. This course, rather than nationalization of the market, would likely improve the distribution system. Nationalization would force the government to assume the present problems of that system.

as 118 for January and February, whereas for the period 1957-1964, seasonal factors were of the same order as for the period 1959-1964. Data for 1959 to 1964 are used in most of the other analysis in the study. (b) The seasonal pattern in the "normal" storage model is based on conservative assumptions. If we use the Delhi storage rate (25 nP per month), a 4-percent annual average deterioration rate, and an 18-percent interest rate, the "normal" price rise for February will be 126.3.

¹⁷ It appears that it was profitable to carry stocks over from one year to the next in only one of the six years studied. Wheat was purchased in June 1962 for Rs.38.00 and was sold in December 1963 for Rs.56.00 (or Rs.61.00 in February 1964, although very limited stocks were available this late). The carrying costs on the conservative cost basis—including charges for labor (32 nP), bag loss (40 nP), rent (72 nP), deterioration (Rs.3.61), and interest (Rs.4.95)—total approximately Rs.10 for 18 months. With the exception of the period from April-May 1958 (with exceptionally low prices) to December 1959, when carry-over might have broken even, all other commercial carry-over operations would have shown losses.

¹⁸ Regressions were fitted relating Khanna prices to different combinations of Delhi prices, Khanna prices, Khanna dispatches, and Khanna stocks. The Khanna variables added little to the explanatory power of Delhi price alone.

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Monopolistic Cocoa Pricing

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Although attempts to introduce international regulation as a device to benefit cocoa producing countries have failed in the past five years, considerable pressure remains to try again. In this study, estimates are formed of the probable changes in some of the relevant variables if an international monopolistic cocoa pricing agreement were implemented. On the basis of new estimates of cocoa supply and demand relations, effects of the hypothetical institution of discriminatory monopolistic pricing in 1964 are examined. Such an agreement would have resulted in marginal, although possibly important, additions to the leading cocoa producing countries' command over external resources; but stock accumulation or surplus disposal problems might have been troublesome, and long-run supplies would have increased substantially unless producers were effectively isolated from the world market.

MONOPOLISTIC pricing is defined as by Pincus to be the reduction of supplies of an internationally traded commodity through a coordinated policy of the producing nations in order to increase the product price and therefore the profits of the producing nations [13]. The world cocoa market is of interest for at least two reasons. First, cocoa exports provide a substantial portion of the foreign exchange for a number of less-developed countries in West Africa and in the Caribbean (Table 1, col. 1). Second, in the past five years, three substantial, but unsuccessful, attempts have been made to institute some form of international regulation in the world cocoa market. The 1963 and 1966 United Nations-sponsored negotiating conferences failed, primarily because of lack of agreement on the minimum price at which supplies would be regulated by quotas [11, Oct. 25, 1963, p. 41, and June 29, 1966, p. 49; 17, pp. 94, 98, 313].¹ The attempt by the Cocoa Producers' Alliance (the members of which—Ghana, Nigeria, Brazil, Ivory Coast, the Cameroun Republic, and Togo—produced 79 percent of the world crop in 1960-61 through 1964-65) to withhold the 1964-65 crop until prices rose to 26.6 cents per pound failed because some of the producers did not withhold all of their sup-

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¹ The final act of the 1966 negotiating conference was the approval of a resolution which requested that the Secretary-General of the UNCTAD reconvene the conference before the end of 1966. The Secretary-General did not do so, however, because he thought that prospects for an agreement had not improved sufficiently. The conference may be reconvened in the near future if such prospects do improve sufficiently.

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plies and because the purchasers of cocoa were skeptical about the eventual success of the agreement and had sufficient supplies to wait out the Alliance [11, Dec. 7, 1964, p. 55, and Feb. 7, 1965, Sec. 3, p. 5].

To provide the framework for the examination of the implications of monopolistic pricing in the world cocoa market, the next two sections are devoted to a brief examination of the supply and demand for cocoa, with special emphasis on the characteristics which are relevant to the success (or failure) of an international monopolistic price agreement. In the final section, the possible implications of establishing a monopoly price in the cocoa market are examined more specifically.

The Supply of Cocoa

In respect to establishing a monopolistic price in the world cocoa market, five characteristics of the supply of cocoa seem most important: (1) the concentration of production in a few of the less-developed countries, (2) the dominance of a relatively few standard grades in international trade, (3) the limited short-run supply response to economic incentives, (4) the substantial long-run supply response to economic incentives, and (5) the existence of government marketing institutions in many of the major producing countries. Each of these characteristics will now be examined in turn.

First, cocoa production is concentrated in relatively few countries, largely because of the exacting ecological requirements of the trees.² Over the 1960-61 through 1964-65 crop years, the five largest producing countries accounted for 78 percent and the eight largest producing countries accounted for 86 percent of the world supply (Table 1, col. 2). This concentration of production should facilitate the negotiation and implementation of an international commodity agreement, *ceteris paribus*, because the number of parties to the agreement need not be extremely large. That production is concentrated in countries with low per capita incomes, moreover, means that any benefits of a monopolistic price would accrue to less-developed areas and that the domestic agricultural protectionist policies of the more-developed countries are not likely to impede the negotiation of an international agreement.³

² Cocoa trees thrive only within 20 degrees of the equator, and most of the world production is within 10 degrees. A mean shade temperature of approximately 80 degrees Fahrenheit with variations not more than ± 15 degrees, a well-distributed rainfall of at least 50 inches annually, an altitude between a few hundred feet and a thousand feet above sea level, and protection from strong winds are all usually required. A firm estimate of the percentage of the suitable area which is already under cocoa cultivation, however, is not available [15, p. 2].

³ Such policies are a major impediment to the establishment of more satisfactory international trade (from the viewpoint of the less-developed countries) for such commodities as sugar, meat, and grains.

Table 1. Leading cocoa producing countries: value of cocoa as a percentage of all exports, distribution of world production, price elasticities of supply

Country	Cocoa exports as a percentage of value of all exports, 1960-1963 ^a	Percentage of world cocoa production, 1946-47 through 1964-65 ^a	Price elasticity of supply ^b	
			Short-run	Long-run
Ghana	66.0	36.5	—	0.71
Nigeria	19.3	17.3	—	0.45
Brazil	4.7	9.3	0.53	0.95
Ivory Coast	21.4	8.3	—	0.80
Cameroon Republic	28.0	6.4	0.68	1.81
Ecuador	12.6	3.2	—	0.28
Dominican Republic	6.7 ^c	3.1	0.03	0.15
Venezuela	3.5	1.6	0.12	0.38

^a Calculated from data in Gill and Duffus [9] and United Nations [14].

^b Calculated at means from supply regressions for 1946-47 through 1963-64 given in Table A.1 of Appendix A. Short-run elasticity is defined as the response in harvesting and husbandry over a time period too short for new plantings to come into bearing. Long-run elasticity is defined as the response after newly planted trees have come into full bearing and all other adjustments have occurred.

^c 1960-1962.

Second, most cocoa which is traded in the international market is one of a few relatively standard grades, the prices of which move more or less in unison [1, p. 49, and 9, p. 35]. Separate arrangements, therefore, probably would not have to be made for each grade.

Third, the short-run cocoa supply response to economic incentives apparently is limited. Conscious short-run variation of production within the constraints set by the available stock of trees is possible. The care of trees can be lessened or trees can be left unharvested. In the statistical analysis which is summarized below, however, no significant short-run response to price was evident for four countries which together accounted for almost two-thirds of the world's cocoa supply in the period from 1960-61 through 1964-65 (Table 1, cols. 2 and 3, and Appendix A). Perhaps in these countries the opportunity cost of long-run deterioration due to short-run neglect of trees is sufficiently high and the marginal cost of harvesting the pods from the existing stock of trees is sufficiently low so that short-run supply has been insensitive to variations in price of the magnitude which has occurred historically.⁴ Because of this short-run inflexibility, an attempt to maintain a high price for cocoa by limiting the supplies for all or part of the international market might have to be accompanied by consid-

⁴ For a range of observations on the short-run supply response and for further references, see Amoa [1, p. 50], Bateman [4, pp. 124, 141], *New York Times* [11, April 28, 1965, p. 67], Organization for European Economic Cooperation [12, p. 24], Pincus [13, pp. 37-38], and Viton [18, p. 33].

erable storage or nontraditional disposal procedures in order to be successful.⁵

Fourth, the long-run cocoa supply response to economic incentives apparently is substantial (although relatively small in the oldest producing areas—Ecuador, the Dominican Republic, and Venezuela: Table 1, col. 4, and Appendix A). If a monopolistic price were to be established and if therefore it were desirable to prevent a substantial increase in future supplies due to new plantings, the producers (and potential producers) would have to be isolated from the world market price or planting would have to be restricted by effective regulations.

Fifth, the existence of government marketing boards or a history of government control of cocoa exports in most of the major producing countries is favorable to the establishment of an effective international commodity agreement in that institutions are available for the control of supplies in individual countries and for the isolation of producers from the world markets [12, pp. 26–30, 72–73, 88–89; 13, pp. 17, 27; 16, pp. 11–14].

The Demand for Cocoa

In respect to establishing a monopolistic price, four characteristics of the derived demand for cocoa seem most relevant: (1) the concentration of consumption in a few developed nations with oligopolistic chocolate markets, (2) the generally quite inelastic short-run price response of the derived demand function, (3) the moderate responses to changes in the prices of complements and substitutes, and (4) the potential long-run responses to high prices for cocoa beans. Each of these characteristics will now be discussed in turn.

First, the consumption of cocoa is concentrated in countries with high per capita incomes in Europe and North America in which chocolate markets are basically oligopolistic. The eight countries in Table 2 accounted for over two-thirds of the world consumption of cocoa products in the 1960–1964 period. This concentration might aid in the establishment of a workable international commodity agreement for cocoa, once again, in that a relatively limited number of parties to the agreement might be required to make the agreement effective.⁶ This same concentration of con-

⁵ For example, large numbers of trees have been planted in West Africa in the past decade and will increase world supplies when they attain the age for mature yields, independently of whether or not a reduction in world supply becomes advisable [15, pp. 7–19].

⁶ Consuming countries, of course, do not need to be parties to a monopolistic price agreement in order for it to be effective. The producers alone may establish a monopolistic price by restricting the supplies, as the Cocoa Producers' Alliance unsuccessfully attempted to do in the 1964–65 season. If consumers are parties to the agreement, however, the probabilities of success (from the viewpoint of producers) are greater, *ceteris paribus*, because the pressure to reduce the price may be less, especially if the con-

Table 2. Leading cocoa consuming countries: distribution of consumption in bean equivalents and elasticities of demand for bean equivalents

Country	Consumption of cocoa products in bean equivalents ^a				
	Percentage of world total 1960-1964	Elasticity of per capita consumption ^b with respect to			
		price of cocoa	per capita income	price of sugar	price of soybean oil
United States	28.5	-0.25	—	0.08	0.19
Federal Republic of Germany	12.6	-0.18	0.93	—	0.32
United Kingdom	10.4	-0.16	0.71	—	0.40
France	6.1	-0.38	0.68	0.15	0.05
Canada	2.5	-0.19	0.72	-0.12	0.43
Netherlands	2.5	-0.89	0.62	—	0.77
Spain	2.2	-0.24	0.85	—	—
Italy	2.1	-0.21	0.93	—	0.05
Rest of world	33.1	-0.25	—	0.20	-0.74

^a Bean equivalents are grindings of beans adjusted for net exports of cocoa butter, cocoa powder, cocoa paste, and chocolate products, as calculated from data in Gill and Duffus [9].

^b Calculated at means from demand regressions in Table B.1.

sumption in countries in which the chocolate markets are oligopolistic, however, makes more difficult in at least one respect the negotiation of an international cocoa agreement which includes the major consuming countries and which may be interpreted as benefiting the producing countries at the expense of the consuming countries: the major chocolate manufacturers can strongly resist such an agreement because of their market power in dealing with cocoa suppliers and because of their organized political influence on their own governments.

Second, the estimates of the price elasticity for the derived demand for cocoa beans indicate a limited short-run response (Table 2, col. 2, and Appendix B).⁷ These inelastic price responses, in turn, imply that the revenue of the cocoa producers could be increased by restricting cocoa supplies and increasing the world price (Table 3, cols. 5 and 6).

Third, sugar and vegetable oil are apparently, on balance, both basically substitutes for cocoa beans (Table 2, cols. 4 and 5, and Appendix B). Changes in the price of sugar apparently do not affect substantially the demand for cocoa beans, but for three of the five largest consuming

sumers discriminate against producers who are not parties to the agreement [16, pp. 27, 29].

⁷ The response in the derived demand for cocoa beans reflects both changes in the composition of cocoa products (predominantly chocolate) and changes in the demand for such products [1, pp. 53-55, 62-67, 115, 119, 124, 146, 157].

countries, the estimated cross elasticity of the derived demand with respect to vegetable oil prices is greater than the estimated own-price elasticity. One implication of this result is that monopolistic cocoa prices may result in considerable substitution of vegetable oil for cocoa butter.

Fourth, long-run responses to a monopolistic price are less predictable but presumably are much larger than short-run responses. For many uses of cocoa butter, no satisfactory substitute is currently available because of

Table 3. Estimates of the effects, on demand for cocoa by eight leading consuming countries and on the resulting total revenue of cocoa producers, of alternative cocoa prices, 1964^a

Price per pound ^b	Calculated annual demand (for price in col. 1) ^c	Difference between calculated demand and actual demand ^d	Calculated annual revenue (col. 1 times col. 2) ^e	Difference between calculated and actual revenue ^f	Percentage change in total revenue from cocoa ^g
U.S. cents	thousands of tons of bean equivalents	thousands of tons of bean equivalents	million 1964 U.S. dollars	million 1964 U.S. dollars	percent
12.2 ^h	825.8	76.3	226	-172	-33.1
20.0 ^h	779.5	20.0	343	-55	-10.6
20.6 ⁱ	775.8	16.3	348	-50	-9.6
22.5 ^j	764.5	5.0	382	-16	-3.8
23.0 ^k	761.5	2.0	390	-8	-1.5
23.6 ^l	757.8	-1.3	400	2	-0.4
26.6 ^m	740.3	-19.3	441	43	8.3
27.0 ⁿ	737.3	-22.3	446	48	8.9
29.0 ^o	725.7	-34.6	471	73	14.0
46.3 ^p	622.5	-137.0	645	247	47.5
62.7 ^q	525.5	-234.0	739	341	66.6
74.3 ^r	456.0	-303.5	758	360	68.3
75.6 ^s	448.5	-311.5	760	362	69.7
80.0 ^t	422.5	-337.5	755	357	68.7

^a The eight countries which are included are listed in Table 2. Together they accounted for two-thirds of the world consumption of cocoa beans in 1960-1964.

^b New York spot price of Ghanaian cocoa.

^c Given 1964 levels of income, population, and prices of sugar and of soybean oil, the aggregate demand schedule for cocoa in 10³ tons of bean equivalents for the eight countries is

$$D_1 = 898.5 - 5.95 PC_1$$

where PC_1 is the spot price of Ghanaian cocoa in New York in 1954 U. S. cents per pound. This demand schedule is the sum of the individual-country demand schedules, which are summarized in Table B.1.

^d The actual grindings in the eight countries of concern (adjusted for trade in cocoa products) totaled 759.5 × 10³ tons in 1964.

^e All revenues to which reference is made are calculated at New York prices under the assumption that all cocoa is sold at such prices. Prices which producers receive are presumably less than the New York prices by the cost of transportation and associated charges. Approximately one-third of the sales of the Nigerian and Ghanaian marketing companies, moreover, are the result of direct negotiations with large firms, and the prices for such sales presumably differ from the prices of Cocoa Exchange sales [10, p. 117].

^f Change from actual 1964 revenue, under the assumption that exports to other countries remain at actual 1964 level. The total quantity of bean equivalents consumed in 1964 multiplied by the average spot price of Ghanaian cocoa on the New York market equaled \$520 million and was used as the base for the percentages which are given in this column.

^g July 1965 price, calculated from data in Gill and Duffus [9] and United Nations [14].

^h Minimum price suggested by consumers at 1963 conference, calculated from data in the *New York Times* [11, Oct. 25, 1963, p. 41, and Dec. 7, 1964, p. 55].

ⁱ February 1965 price [9, 14].

^j Average price for 1961, [9, 14].

^k January 1965 price [9, 14].

^l October 1964 price [9, 14].

^m Producers' Alliance minimum price, 1964-65 [11, Oct. 25, 1963, p. 41, and Dec. 7, 1964, p. 55].

ⁿ Minimum price suggested by producers at 1963 conference [11, Oct. 25, 1963, p. 41, and Dec. 7, 1964, p. 55].

^o Pincus' "monopoly price" [13, p. 47].

^p Average price for 1958 [9, 14].

^q Average price for 1954 [9, 14].

^r July 1954 price [9, 14].

^s Calculated price to maximize gross revenue, obtained by maximizing the product of D_1 and PC_1 , given the expression for D_1 in note c above.

^t Arbitrarily chosen price.

cocoa butter's property of melting at slightly under the human body temperature. Reputedly, the high cocoa prices for the 1953-54 and 1958-59 crops encouraged considerable although unsuccessful research in an effort to find a relatively cheap substitute for cocoa butter which has a comparable melting temperature. If monopolistic cocoa prices were established, such research would probably be intensified again, and, if it were successful, the long-run demand curves for cocoa beans would shift down considerably. High cocoa prices, moreover, may lead to changes in taste which are detrimental to cocoa producers if the composition of chocolate is altered to reduce the cocoa content and remains so altered for a long period of time [1, p. 55; 12, pp. 102-103; 16, p. 4; 18, p. 51].

Some Quantitative Effects of Monopolistic Pricing in the Cocoa Market

Within the framework of supply and demand which has been described in the previous two sections, some quantitative statements about the effect of monopolistic cocoa pricing may be made. Each row in Table 3 summarizes the implied effects on demand for cocoa beans for current consumption and on total revenue of cocoa producers in 1964 if various proposed or historical cocoa prices had prevailed in that year. Before these hypothetical effects are examined, the assumptions which underlie Table 3 should be made explicit. (1) The prices in column one are assumed to be accepted as the prevalent prices for the foreseeable future by the consumers. There is assumed to be no activity by cocoa purchasers, therefore, which is motivated by an attempt to lower future cocoa prices. (2) The demand equations for the eight leading consuming countries, which are summarized in Tables 2 and B.1, are assumed to prevail, even though they are based on a period in which no effective international organization of the cocoa market existed. This assumption is the more unrealistic, of course, the more the hypothesized prices diverge from the range of actual prices for the period over which the demand functions were estimated (1948-1964).⁸ (3) The producers of cocoa are assumed to be operating successfully as discriminating monopolists and selling cocoa at the 1964 prices for the actual 1964 stock additions and for the actual 1964 consumption in the rest of the world.⁹ (4) All variables other than the

⁸ In the 1948-1964 period, the average annual spot price of Ghanaian cocoa on the New York Cocoa Exchange in 1964 U.S. cents per pound ranged from 21.0 to 62.7.

⁹ This assumption was made because of the unsatisfactory estimates which were obtained for the demand for current consumption in the rest of the world and for the demand for current stock additions in the total world. If these demands in reality are not unitary-elastic at the actual 1964 price, the third assumption results in an undercalculation of the percentage increase in revenues which would be possible with discriminatory monopolistic pricing.

price of cocoa in the arguments of the demand function are assumed to have the actual 1964 values.

Under these assumptions, columns five and six give the monetary and percentage increases in the revenue from the sale of cocoa which would result from various prices, in comparison with the revenue obtained from the actual 1964 price and sales. If the demand for current consumption in the eight leading consuming countries had been satisfied at the Cocoa Producers' Alliance desired minimum price of 26.6 cents per pound, the implied revenue would have increased \$43 million or 8.3 percent. If the demand for current consumption in the eight leading consuming countries had been satisfied at the implied revenue-maximizing price of 75.6 cents per pound, the implied revenue would have increased \$362 million or 69.7 percent.¹⁰

To illustrate the implied impact of various revenue changes on the external resources which would be available to the various cocoa producing countries, Table 4 has been constructed under three further assumptions: (1) The incremental revenue is distributed to the cocoa producing countries in proportion to each country's share of total world cocoa production in the period from 1960-61 through 1964-65 (Table 1, col. 2). (2) The actual export value for each of the leading cocoa producing countries in 1964 was composed of cocoa exports and other exports in the proportions indicated in column one of Table 1. (3) The value of noncocoa exports for each of the leading cocoa producing countries would remain the same in 1964 no matter what happened to the value of cocoa exports for that year.

Examination of Table 4 indicates that if the demand for current consumption in the eight leading consuming countries had been satisfied at the Cocoa Producers' Alliance desired minimum price of 26.6 cents per pound (a 13.7-percent increase over the actual price which prevailed in 1964), only for Ghana and the Cameroun Republic would the implied increase in earnings from total exports have been as large as 2 percent.¹¹ If the demand for current consumption in the eight leading consuming countries had been satisfied at the implied revenue-maximizing price of 75.6 cents a pound (a 211-percent increase over the actual price which

¹⁰ Given the aggregate demand function of this study, Pincus' "monopolistic price" of 29 cents a pound is substantially below the revenue-maximizing price, which in turn is below the true profit-maximizing price (unless the short-run marginal cost is zero at the output where the price elasticity is one). The profit or "resource-maximizing" price evidently is somewhat higher than the revenue-maximizing price because, for some major producing countries, the existence of a significant short-run response (Table 1, col. 3) suggests the existence of positive short-run marginal costs. For illustrative purposes in this study, however, the revenue-maximizing price is utilized.

¹¹ The percentage change in total foreign exchange for the countries is even smaller if the country receives net capital inflows.

Table 4. Percentage change in value of total exports in 1964 in eight leading cocoa producing countries if alternative prices had prevailed in the world cocoa market^a

Price per pound in 1964 ^b	Ghana	Nigeria	Ivory Coast	Cameroun Republic	Brazil	Ecuador	Dominican Republic	Venezuela
<i>U.S. cents</i>								
12.2	-22.5	-6.4	-7.1	-9.3	-1.6	-4.2	-2.2	-1.2
20.0	-7.0	-2.0	-2.3	-3.0	-0.5	-1.4	-0.7	-0.4
20.0	-6.3	-1.9	-2.1	-2.7	-0.5	-1.2	-0.6	-0.3
22.5	-2.5	-0.7	-0.8	-1.0	-0.2	-0.5	-0.3	-0.2
23.0	-1.0	-0.3	-0.3	-0.4	-0.1	-0.2	-0.1	-0.1
23.6	0.2	0.1	0.1	0.1	0.0	0.0	0.0	0.0
26.6	5.5	1.6	1.8	2.4	0.4	1.1	0.6	0.3
27.0	5.9	1.7	1.9	2.5	0.4	1.1	0.6	0.3
29.0	9.2	2.7	3.0	3.9	0.7	1.8	0.9	0.5
46.3	31.7	9.2	10.2	13.4	2.3	6.0	3.1	1.6
62.7	44.0	12.9	14.3	18.7	3.1	8.4	4.4	2.3
74.3	45.2	13.2	14.7	19.2	3.2	8.6	4.5	2.4
75.6	46.0	13.5	15.0	19.6	3.3	8.8	4.7	2.5
80.0	45.4	13.3	14.8	19.3	3.2	8.7	4.6	2.4

^a Calculated from columns one and two in Table 1 and column six in Table 3 by the procedure which is described in the text.

^b New York spot price of Ghanaian cocoa. The choice of representative prices is explained in the notes to Table 3.

prevailed in 1964), only for Ghana would the implied increase in earnings from total exports have been as large as 20 percent. Table 4 suggests, thus, that substantial increases in cocoa market prices would have resulted in relatively small increases in the command over external resources for the major cocoa producing countries.

Thus far, concern has been focused on changes in the quantity of cocoa beans demanded and in the revenue of cocoa producing nations. Column three of Table 3 indicates, however, that there may be a problem of disposing of considerable amounts of cocoa if the hypothesized discriminatory monopolistic price is much above the actual 1964 market price. Numerous options exist for such disposal: (1) The surplus could be added to a buffer stock which later could be used to limit price upswings resulting from small harvests due to bad weather.¹² If stocks were to become too big, however, it would seem unlikely that consumers would believe that the current monopolistic price could be maintained for long, and they might act so as to increase the pressure for a reduction in price. To the extent that such stocks were financed by the producing countries, moreover, the maintenance of a buffer stock would reduce the gain from monopolistic pricing. (2) The surplus could be left to rot on the trees or be destroyed after harvesting at a relatively small cost. (3) The surplus could be sold to the rest of the world for traditional uses at lower prices (in addition to the quantities actually sold in 1964 to the rest of the

¹² The use of buffer stocks for this purpose might be one condition on which the cooperation of consuming nations would depend.

world). Unless the price elasticity of demand for cocoa beans of the rest of the world is elastic (or unitary) at the actual prevailing price in 1964, however, this means of disposal also would result in reduced revenues for the cocoa producing nations. (4) Cocoa beans could be diverted to non-traditional uses, such as the manufacture of margarine. Such diversions could increase the revenue of cocoa producing nations in the situation under discussion, but care would have to be exercised to prevent such cocoa from being used in the manufacture of traditional cocoa products.¹³

Finally, one can inquire what would be the effect of various prices on long-run production of cocoa? If marketing boards were effectively to isolate the cocoa producers from the world market price, long-run supplies should be unaffected. If marketing boards were to vary producers' prices with the fluctuations in world prices, however, planting would respond accordingly.¹⁴ Assume, for example, that marketing boards varied producers' prices in direct proportion to the monopolistic price. If the Cocoa Producers' Alliance minimum price were the monopolistic price, therefore, the estimates in Table 1 imply that the long-run supply of cocoa would be 10.1 percent greater than it would have been had the actual 1964 price prevailed.¹⁵

The quantitative estimates which have been presented in this section must be qualified heavily because of the underlying statistics, the many special assumptions, and the comparative statics analysis. The results, nevertheless, do seem suggestive. Monopolistic cocoa pricing agreements apparently could be utilized to add marginally to the external resources of the cocoa producing nations, and such marginal additions might provide considerable aid to the process of development. A monopolistic pricing agreement, however, would be far from a panacea for the economies of the cocoa producing countries. At practically obtainable price levels the benefits would be limited, and the economic and political opportunity costs of negotiating and maintaining such an agreement might be substantial. The producing nations, thus, should not harbor unrealistic expectations about the rewards which they would receive if such an agreement were to be implemented.

¹³ According to a report in the *New York Times* [11, Feb. 7, 1965, Sec. 3, p. 51], the price of cocoa would have to drop to below five cents per pound in order for cocoa to be competitive with vegetable oils in the manufacture of margarine. If a margarine producer were able to obtain cocoa at such a price, the temptation to resell it at market prices would seem almost irresistible.

¹⁴ The extent to which marketing boards have varied producers' prices with the fluctuations in world prices is a matter of some dispute [4, pp. 58-64; 19, pp. 678-698].

¹⁵ The implied aggregate long-run supply elasticity in Table 1 is 0.74. The long-run increase in output due to a 13.7-percent increase in price, thus, would be $0.74 \times 13.7 = 10.1$ percent.

Appendix A

Cocoa Supply Model Estimates

For each of the eight leading cocoa producing countries, the supply model in equation (A.7) was estimated. The derivation of this model and some comments on the estimates are the subjects of this appendix.

The model which was used draws substantially on the work of Bateman [3, 4, 5, 6, 20]. Bateman's currently published estimates, however, are based on the assumption that the actual area planted in cocoa trees is a function of expected prices over the bearing period of the trees. A preferable assumption would seem to be that the *desired* area in cocoa trees in the t th period (A_t^d) is a function of the producers' real price expectations held at time t both for cocoa (PC_t^e) and for the main alternative crop, coffee (PCF_t^e)¹⁶:

$$(A.1) \quad A_t^d = a_{10} + a_{11}PC_t^e + a_{12}PCF_t^e + u_{1,t}.$$

The actual area in trees at time t (A_t) is hypothesized to be a function of the desired area in trees¹⁷:

$$(A.2) \quad A_t = a_{20} + A_{t-1} + a_{21}(A_t^d - A_{t-1}) = u_{2,t}.$$

The expected real prices¹⁸ of cocoa (PC_t^e) and of coffee (PCF_t^e) over the lifetime of the cocoa tree are hypothesized to be a weighted average of all past actual real prices (PC_{t-i} , PCF_{t-i}):

$$(A.3) \quad PC_t^e = a_{30} + PC_{t-1}^e + a_{31}(PC_{t-1}^e - PC_{t-1}) + u_{3,t}$$

and

$$(A.4) \quad PCF_t^e = a_{40} + PCF_{t-1}^e + a_{41}(PCF_{t-1}^e - PCF_{t-1}) + u_{4,t}.$$

In addition, in order to conserve degrees of freedom, the two adjustment coefficients (a_{31} and a_{41}) are assumed equal.

¹⁶ Other possible determinants of desired area in cocoa might include expected yields per unit area of cocoa relative to other crops (especially if one has reason to expect substantial changes in relative yields), expected relative costs, and proxies for the relative variances in the subjective probability distributions of prices. None of these possibilities was examined in the present study.

¹⁷ This form of adjustment is unrealistic in that the rate of real-world adjustment probably is a function of $(A_t^d - A_t)$. If A_t^d is greater than A_t , moreover, the adjustment coefficient may be a function of available liquid reserves [2, p. 14; 13, p. 59; 21, p. 276]. Despite its limitations, however, equation (A.2) was utilized in the present study to approximate the adjustment relationship because its distributed lag form permits manipulation to obtain relations in terms of observable variables without the sacrifice of too many degrees of freedom.

¹⁸ These price-expectation relationships have advantages and disadvantages analogous to those mentioned in the previous footnote.

These four equations (A.1-A.4) can be manipulated to obtain an expression for the current area in cocoa trees in terms of observable prices. Satisfactory time-series data for area in cocoa trees is not available, however, so one must work with the quantity actually produced (Q_t). The quantity produced in the t th year is a weighted sum of all past areas planted in cocoa, in which the area planted in the $(t-i)$ th year (ΔA_{t-i}) is weighted by the average yield per unit of area i years after planting, $y(i)$.¹⁹ In addition, this weighted sum of past plantings must be adjusted for possible responses in husbandry to real cocoa prices lagged one period and to possible responses in harvesting to current real cocoa prices²⁰:

$$(A.5) \quad Q_t = a_{50} + \sum_{i=0}^{\infty} y(i) \Delta A_{t-i} + a_{51} PC_t + a_{52} PC_{t-1} + u_{5,t}.$$

The average yields per tree in the i th year after planting follow a distinctive pattern for most important cocoa varieties. The yield per tree is practically zero until the fifth through the eighth years, at which stage the yield per tree increases substantially. Yields per tree thereafter remain relatively constant until the eleventh through the fifteenth years, at which stage another substantial increase often occurs. After this second increase, yields per tree increase slowly for many years and then decrease slowly as senility sets in. Trees often live for 40 years, and many live twice that long [1, p. 48; 2, p. 14; 4, pp. 79-83; 10, pp. 1-2; 13, pp. 10, 26, 32; 21, pp. 283, 292].

The patterns in yields per unit of planted area, $y(i)$, over the course of time reflect the distinctive pattern in yields per tree. Yields per area are negligible for the years immediately after planting and then increase abruptly—to $y(n_1)$ in the n_1 th year—to what is almost a plateau. The yields per unit of area then may increase relatively abruptly—to $y(n_2)$ in the n_2 th year—to a higher plateau, on which the increasing yields per tree are approximately offset by the loss of trees.²¹ Eventually, senility and the loss of trees prevail, and yields per unit of area gradually decline. Because of this distinctive pattern in yields per unit area, the infinite sum in equation (A.5) may be eliminated (approximately) by taking the first difference:

$$(A.6) \quad \Delta Q_t \cong y(n_1) \Delta A_{t-n_1} + [y(n_2) - y(n_1)] \Delta A_{t-n_2} + a_{51} \Delta PC_t + a_{52} \Delta PC_{t-1} + \Delta u_{5,t}.$$

To obtain a supply expression in terms of observable variables, equa-

¹⁹ Of course, $y(i)$ may have a value of zero.

²⁰ See fn. 4.

²¹ Estimated values for n_1 and n_2 for the leading producing countries are given in Table A.2.

tions (A.1–A.4) and (A.6) may be manipulated to eliminate A_{t-1} ^d and A_{t-2} :

$$(A.7) \quad \Delta Q_t \cong b_1 \Delta Q_{t-1} + b_2 \Delta Q_{t-2} + b_3 \Delta PC_t + b_4 \Delta PC_{t-1} \\ + b_5 \Delta PC_{t-2} + b_6 \Delta PC_{t-3} + b_7 \Delta PC_{t-n_1} + b_8 \Delta PCF_{t-n_2} \\ + b_9 \Delta PC_{t-n_1} + b_{10} \Delta PCF_{t-n_2} + u_{7,t},$$

where the b_i 's are algebraic combinations of the a_i 's, $y(n_1)$, and $y(n_2)$.

Ordinary least-squares estimates of the coefficients of the variables in equation (A.7) were obtained for each of the eight leading cocoa producing countries, under the assumption that the disturbance term in equation (A.7) (which is the weighted sum of the differenced and lagged disturbance terms in the underlying five equations) is distributed independently of the variables on the right-hand side with an expected value of zero, with a constant own variance, and with no autocorrelation. Such estimates are inefficient because the information about the relations between the coefficients in equation (A.7) was not utilized in the estimation procedure. The estimates are summarized in Table A.1.

Because the adjustment coefficients (c_{21} and a_{31}) enter symmetrically into the definitions of the coefficients of equation (A.7), a two-point identification problem exists. The signs of the estimates suggest, however, that at least one of these coefficients (and both for Nigeria, Brazil, and the Dominican Republic) is greater than one in value. Overadjustment in planted area or in price expectations, thus, seems to be the rule.

The estimates do not explain the variance in production as well as do Bateman's estimates for the regions in Ghana. Two possible reasons for the relative lack of success in this study are (1) the failure to include important weather factors because of the unavailability of data and (2) the level of aggregation at which the present analysis was performed. The estimates do suggest long-run price elasticities, however, of the same order of magnitude as those which Bateman obtained [4, pp. 129–172].²²

Appendix B

Estimates of the Demand for Cocoa Consumption in Bean Equivalents

Estimates of the demand for cocoa for current consumption in eight leading consuming countries and in the rest of the world are presented in Table B.1. In this appendix the arguments in the demand function and the estimates are discussed.

²² See column four in Table 1 for the long-run price elasticities implied by Table A.1. Bateman's analysis [4, pp. 89–91 and 122–173] was performed on a regional level, and rainfall and humidity were both found to be important determinants of output.

Table A.1. Least-squares estimates of cocoa supply response model for eight leading cocoa producing countries, 1947-48 through 1963-64^a

Country	Least-squares estimates (with standard errors in parentheses) of coefficients of										\bar{R}^2
	ΔQ_{t-1}	ΔQ_{t-2}	ΔPC_t	ΔPC_{t-1}	ΔPC_{t-2}	ΔPC_{t-3}	ΔPC_{t-n_1}	ΔPC_{t-n_2}	ΔPCF_{t-n_1}	ΔPCF_{t-n_2}	Constant
Ghana		0.267 (0.19)					0.410 (0.34)	0.970 (0.28)			5.20 (9.2)
Nigeria	-0.474 (0.23)	-0.249 (0.22)					0.307 (0.30)	0.503 (0.23)			8.17 (6.1)
Ivory Coast	-0.556 (0.19)	0.234 (0.19)					1.04 (0.28)	1.13 (0.33)	-0.617 (0.38)		3.88 (2.7)
Cameroun Republic		-0.538 (0.15)	0.084 (0.063)	0.119 (0.061)			0.332 (0.069)				3.27 0.76
Brazil	-0.327 (0.26)	-0.202 (0.24)		1.27 (1.12)	0.564 (0.80)	0.199 (0.92)	1.59 (0.95)	1.35 (1.5)			-1.69 (9.2)
Ecuador	-0.721 (0.19)						0.143 (0.096)	0.339 (0.13)	-0.289 (0.14)	-0.295 (0.18)	2.82 (0.97)
Dominican Republic	-1.08 (0.26)	-0.576 (0.31)	0.0918 (0.11)				0.119 (0.13)	0.234 (0.133)	-0.164 (0.14)	-0.292 (0.17)	2.30 (0.91)
Venezuela	-0.849 (0.23)		0.0711 (0.053)	0.0619 (0.057)			0.0553 (0.0503)	0.237 (0.085)	-0.684 (0.68)	-0.197 (0.090)	0.630 (0.482)

^a The model used is presented in equation (A.7) of Appendix A. The variables in the model are also defined in the text of Appendix A. The time lags for planting responses to have substantial effect on supplies (n_1 and n_2) are given for each country in Table A.2. Data sources: production, Gill and Duffus [8]; current producer's price of cocoa in Ghana and Nigeria, Gill and Duffus [9]; price of coffee (Santos No. 4), United Nations [14]; price deflators, United Nations [14] and Vitor [18]; spot price of cocoa (Ghana) in New York, Gill and Duffus [9]. For countries for which no producer price is available, the deflated New York spot price (Ghana) was utilized.

Table A.2. Years after planting in which cocoa yields per unit of planted area apparently increase substantially^a

Country	n_1	n_2
Ghana	8	12
Nigeria	8	12
Ivory Coast	9	14
Cameroon Republic	10	—
Brazil	6	12
Ecuador	8	14
Dominican Republic	7	13
Venezuela	6	9

^a The values of n_1 and n_2 which are presented in this table are those which maximized the coefficient of determination in the estimation of equation (A.7) for each country.

The demand function which was used is

$$(B.1) \quad (C/N)_t = a_{70} + a_{71}PC_{t-1/2} + a_{72}PS_{t-1/2} + a_{73}PS_{t-1/2} + a_{74}(Y/N)_t + u_{8,t}.$$

The dependent variable is the annual per capita grindings of cocoa beans which would have been necessary to provide enough cocoa products for the total consumption of such products in the area of concern (that is, actual grindings adjusted for net imports of cocoa products and divided by the current population). This demand function, thus, is the derived demand function of the users of cocoa products (for example, chocolate manufacturers) for the factor input of raw cocoa beans.

Arguments in this derived demand function include three real prices: the wholesale price of cocoa beans (PC), the wholesale price of sugar (PS), and the wholesale price of vegetable oil (PV). Sugar is a complement to cocoa beans because in chocolate manufacturing as much as 50 percent of the product by weight is sugar. Vegetable oils are both substitutes for and complements to cocoa beans because they may simultaneously substitute for cocoa butter and complement the relatively abundant cocoa powder. All prices are lagged one half year because response in chocolate formulas to changes in cocoa bean prices reputedly require a lag of that length.²³

In addition to the wholesale prices of cocoa and other factors of production, the derived demand function should include variable(s) related to the demand for the final products for which cocoa beans are used as

²³ The price of soybean oils was used to represent the price of vegetable oils because lecithin (an emulsifying agent commercially produced from soybeans) is used to lessen cocoa butter requirements for the reduction of viscosity. Other oils may be used to substitute for cocoa butter, however, in other uses [1, pp. 56, 63-70, 124; 2, p. 19; 12, p. 100; 15, p. 23; 16, p. 8; 21, p. 62].

Table B.1. Least-squares estimates of demand for cocoa bean equivalents for current consumption in leading consuming countries, 1948-1964^a

Country	Least-squares estimates (with standard errors in parentheses) of coefficients of						\bar{R}^2
	PC	PS	PV	Y/N	Constant	N	
United States	-0.00127 (0.00038)	0.00241 (0.000212)	0.00177 (0.00054)		0.235 (0.11)		0.97
Federal Republic of Germany	-0.00262 (0.0013)		0.0102 (0.0023)	0.569 (0.033)	-0.145 (0.15)		0.98
United Kingdom	-0.00295 (0.0021)		0.0160 (0.0042)	0.482 (0.069)	0.0901 (0.18)		0.97
France	-0.00355 (0.0012)	0.00110 (0.00064)	0.0105 (0.0021)	0.241 (0.034)	-0.0031 (0.12)		0.96
Canada	-0.000885 (0.000771)	-0.000412 (0.00038)	0.00397 (0.0013)	0.0850 (0.0235)	0.235 (0.217)		0.91
Netherlands	-0.0143 (0.0093)		0.0252 (0.014)	0.0486 (0.039)	1.10 (0.99)		0.36
Spain ^b	-0.0328 ^b (0.029)			0.0457 ^b (0.0161)	-5.36 ^b (2.6)	-0.415 ^b (3.09)	0.92
Italy	-0.000307 (0.00023)		0.000391 (0.00037)	0.142 (0.013)	0.029 (0.043)		0.93
Rest of world ^b	-0.174 ^b (0.15)	0.102 ^b (0.09)	-0.954 ^b (2.26)		384.5 ^b (60.9)		0.63

^a The demand model is discussed in relation to equation (B.1) in Appendix B. The variables are defined in that discussion. All prices and incomes are in real terms. All prices are lagged six months. Data sources: current price of sugar (New York spot price for United States, London price for United Kingdom, New York spot quotation for export for other countries), current price of soybean oil (New York spot price), national income, population, and price deflators, United Nations [14]; current price of cocoa (if price not available for a particular country, the New York spot price for Ghanaian cocoa was used), bean grindings adjusted for net exports of cocoa butter, powder, and paste, and chocolate products, Gill and Duffus [8, 9].

^b In these regressions total grindings and total income were used instead of per capita grindings and per capita income.

factors. The most important such product is chocolate, the per capita consumer demand for which presumably depends primarily on the level of per capita income, the price of chocolate products, and the price of the major substitute—sugar confectionary. Satisfactory annual time-series data for the last two prices unfortunately are not readily available. To the extent that the wholesale price of sugar is correlated with the price of sugar confectionary, however, PS may serve as a proxy for the substitution of sugar confectionary for cocoa products at the consumption stage. Time series for per capita income (Y/N) in each of the eight leading consuming countries are available and this variable is included in equation B.1 to reflect the effect of shifts in demand for the final product on the derived demand for cocoa beans.

The elasticities which are calculated from the derived demand function are not identical in general to the elasticities which are relevant for the demand for final cocoa products, because the composition of final cocoa products changes with changes in the prices of the relevant factors and because the cost of cocoa beans is but a small part of the total cost of final products [1, pp. 30, 62, 65, 67, 115; 16, pp. 17, 18]. The demand for cocoa stocks is not included in this formulation.

Under the assumption that $u_{s,t}$ is distributed independently of the variables on the right-hand side in equation (B.1), with an expected value of zero, with a constant own variance, and with no autocorrelation, least-squares estimates of the coefficients of that equation are unbiased and efficient. These estimates are presented in Table B.1. The respective coefficients of determination suggest that, with the exception of the Netherlands and possibly the countries covered by the label "Rest of the world," equation (B.1) explains almost all of the variance in the dependent variable.²⁴

The implied own-price elasticities, with the possible exception of the one for the Netherlands, are of the same order of magnitude as has been found in most other studies of the derived demand for cocoa. The implied income elasticity is insignificant for the United States but is greater (although still inelastic) for most of the other seven countries than are estimates reported earlier. The cross elasticities for sugar and vegetable oil prices suggest that the substitution aspects of both of these factors tend to dominate. The cross elasticities with respect to sugar prices are small, but those with respect to vegetable oil prices are large enough to suggest that vegetable oil prices do play an important role in the demand for cocoa.²⁵

²⁴ The estimates given here better explain the variance in adjusted per capita grindings than do those which are presented in my earlier study [7, p. 416].

²⁵ All of the elasticities which are implied by the estimates in Table B.1 are summarized in Table 2 of the text. Other estimates of the derived demand elasticities for cocoa may be found in Bateman [4, p. 182], Behrman [7, p. 416], United Nations [15, p. 28; 16, p. 30; 17, p. 182], and Viton [18, p. 59].

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Technological Change and Internal Economies in Railroad Transport: Some Implications for the Great Plains

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The failure of the railroads in recent decades to maintain either their relative position among the transportation industries or their absolute capital investment does not necessarily presage a continuing withdrawal of resources from the industry. Not only do reported rates of return generally understate the actual rates, but also recent innovations have improved expectations with respect to the future. The unit train, which has both improved service and markedly reduced costs per ton-mile, is of special relevance to a region heavily dependent upon the exportation of grain to distant markets. Furthermore, owing to the comparatively low traffic density of the railroads traversing the Great Plains, the merger of parallel routes would also appear to promise operating economies to an extent not realizable in other sections of the country.

IT IS no secret that the railroads lack the characteristics of a growth industry. Not only have they failed to maintain their relative position in the transport industry, but also they have experienced an absolute decline in the last several decades. Although net investment increased from about \$20 billion in 1921 to more than \$27 billion in 1966, the 1966 investment was only about 75 to 80 percent of the 1921 investment in dollars of constant purchasing power. The decline in employment has been even greater than the decline in capital investment. In 1921, the railroads employed 1,659,513 persons; by 1966, employment stood at 630,895, only 38 percent of the 1921 level. Data on the rate of return (the ratio of net operating income to net property investment) tell a similar story. In only one year (1942) between 1921 and 1966 did the rate of return exceed 6 percent, and in four years (1932, 1934, 1938, and 1961) it was less than 2 percent. Not in the last decade has it been as high as 4 percent [2, pp. 15 and 32; 3, pp. 5 and 22].

As for the relative position of the railroads, each year since 1920, with few exceptions, has found them accounting for a smaller percentage of the nation's freight and passenger transportation. In 1920, the railroads provided the great bulk of the intercity freight ton-miles and passenger-miles. By 1966, they contributed less than 43 percent of the freight ton-miles and less than 2 percent of the passenger-miles [3, p. 39]. Furthermore, while the railroads' share of freight gives at least some indication of having reached a lower limit, passenger traffic continues to approach the vanishing point.

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Are the railroads moribund enterprises whose interment merely awaits the exhaustion of very long-lived capital assets? Has technological change been a significantly weaker factor in railroad than in air, highway, water, and pipeline transportation? Does the much greater permanence of the railroad route than that of the air, highway, and water carrier place it under a crucial handicap in a dynamic economy in which both population and industrial locations are subject to continuous shifting? Has there been a dearth of inventions potentially applicable to the railroads, or has innovation merely been tardy for one reason or another? Let us consider some of these questions.

The Economic Rationale for the Adoption of Innovations by the Railroads

The familiar "shut-down" rule is that, except for very brief periods of time, continued operation presupposes an excess of expected total revenue over expected short-run variable cost. The condition of $TC > TR > TVC$ is a viable one only in the short run, however, and must, in the long run, under static conditions, give rise to the abandonment of productive activity.

There is also a general rule for the replacement of existing assets, to the effect that the total cost of operating with a new technique must be equal to or less than variable cost of the present one if replacement is to occur. Therefore, technological change can obviate long-run withdrawal of resources whenever innovations pass the cost test by a sufficient margin so that $TR > TC$.

Very few enterprises, however, are confronted with the option of complete replacement of existing facilities with new ones. This applies with special force to the railroads. Owing to the durability of much of the capital employed in railroad transport, a railroad typically engages in piecemeal replacement; that is, only a relatively minor portion of its capital is renewed at any one time. Thus, the adoption of innovations in railroad transport is complicated by the fact that, even though a new technique can pass the cost test, a railroad may, nonetheless, find that total costs for its operations as a whole still exceed total revenues. Under such circumstances, it becomes necessary to compare the present value of the future net income streams from the adoption and nonadoption of the innovation rather than merely comparing the variable cost of the old technique with the total cost of the new one during a given income period. Specifically, the inability of innovations to modify the condition in which $TR < TC$ for operations as a whole encourages the adoption of new techniques whose capital costs can be recovered over a relatively brief span of years.¹

¹ During the period 1956-1965, railroad outlays for equipment were more than two and one-half times the investment in roadway additions and betterments, de-

If all innovations were of the cost-reducing variety only, the adoption of new techniques in the railroad industry would be further retarded. This follows from the combination of low variable costs, which typify railroad operations, and the replacement rule that the total costs of a new technique must be equal to or greater than the variable costs of the old one.² Thus, innovations which improve the quality of service, that is, the speed, reliability, convenience, safety, and, insofar as passengers are concerned, the comfort of railway operations, can improve net revenue expectations as much as or more than cost-reducing innovations. To pass the test of profitability, however, the expected total revenue after the adoption of the innovation minus the total cost of using it must be equal to or greater than the expected total revenue from the continued use of existing facilities minus the variable cost of their use.

Given, then, that quality-improving, as well as cost-reducing, innovations may be instituted by an industry that is not currently earning a prevailing rate of return on its investment as a whole, must not the very low rates of return earned by the railroad industry ultimately give rise to far more extensive withdrawal of capital from railroad transport? Granted that a significant amount of the resources now devoted to passenger transportation and branch-line traffic ought to be withdrawn, it does not follow that the railroad industry faces drastic contraction as existing facilities wear out. This is so for the following reasons:

1. Reported rates of return typically understate the return on the investment cost of railroad assets. This disparity arises from the practice, long sanctioned by the Interstate Commerce Commission, of valuing land, not on the basis of acquisition cost, but rather on the basis of the current market value of adjacent land. Inasmuch as some 179,000,000 acres were transferred to the railroads as land grants by the federal and state governments [17, p. 350], rates of return calculated on a net-investment base which incorporates today's high land values do indeed appear depressed.

2. Some portion of the investment in roadbed and tunnels is permanent, or virtually so. The inability of railroads to earn a prevailing return on permanently sunk capital having little in the way of opportunity cost will not necessarily lead to withdrawal from the industry even in the long run.

spite expert judgment that roadway needs were greater and would yield higher returns. But if expected total revenues fall short of expected total costs, how can railroads raise new capital even for relatively short-lived assets? The answer is that newly acquired equipment can serve as collateral for the issuance of equipment trust bonds, or that such equipment, rather than being purchased by the railroad, can be leased from car-leasing companies or supplied by shippers in return for reduced rates.

² Fellner [6, p. 558, fn. 1] has pointed out that, as existing facilities become older, it becomes progressively easier for a new technique to meet the replacement criterion, since increasing maintenance costs will occasion an upward shift in the average-variable-cost curve.

3. Even though the current actual rate of return on investments requiring replacement is less than the rate prevailing in the economy, innovations may establish a condition in which expected future revenues are greater than or at least equal to prospective long-run marginal cost. In short, technological change can transform a nonviable situation into a viable one.

Whether the historical record or the present prospects of technological change in railroad transport augur well for the future of the railroad in the United States is a matter to which we will now turn.

Technological Change in Railroad Transport: The Record and the Prospects

Perhaps the most widely used measure of technological change is the index of output per man-hour. Mansfield has noted that between 1890 and 1925, output per man-hour rose at the rate of 2.5 percent per year in railroad transport, 2.6 percent per year in all transportation, and 2.0 percent per year for the economy as a whole. On the other hand, between 1925 and 1953, the annual rates were 3.0 percent for railroads, 4.5 percent for all transportation, and 2.4 percent for the economy as a whole. Finally, for the entire period, 1890 to 1953, output per man-hour in railroad transportation increased at the rate of 2.8 percent per year [11, pp. 171-172].

Increases in output per man-hour, of course, may occur as the result of changes in the quantity, as well as the quality, of capital resources employed.³ If output per total factor input for 1890 is compared with that for 1953, the effect of changes in the quantity of capital will be eliminated from the results. Output per total factor input rose by 2.6 percent per year during this 64-year span [11, p. 172]. In other words, of the increase in output attributable to capital and labor inputs, only 7 percent was a consequence of increases in the quantity of capital. While it is common to attribute all of the remainder to improvements in the quality of the capital resources, it is clear that at least some of the productivity increase may arise from qualitative changes in the labor force as well.⁴

Since 1953, output per man-hour in railroad transport has increased even more rapidly than it did earlier. Mansfield notes that between 1953 and 1961, output per man-hour rose at an annual rate of 5.8 percent [11, p. 174]. For the period 1953-1965, the rate was 6.5 percent [19, p. 237], more than double the rate of productivity increase for the economy as a whole.

What changes in technology account for the rapid increase in output

³ The capital-labor ratio was 50 percent higher in 1953 than in 1890 [11, p. 172].

⁴ On the other hand, the failure to effect adjustments in work rules as the productivity of capital increased may well mean that the "quality" of labor in railroad transportation underwent a decline between 1890 and 1953. Nelson [14, pp. 171-180] discusses some of the consequences of work rules which have become outmoded as a result of technological change.

per man-hour over the course of the last decade or so? While any enumeration will fall rather short of cataloging all the innovations responsible for the increases in productivity in railroad transport, the most important appear to be dieselization, centralized traffic control, automated classification yards, containerization, unit and integral trains, automated maintenance of way, continuous welded track, and large and specialized freight cars, for example, covered hopper, auto rack, and tank cars.⁵

One of these innovations, the unit train, is of special relevance to the Great Plains area. Although the unit train has been used most extensively in the transportation of coal and iron ore [10, pp. 22-23 and 32-35], Southern Railway's reduced rate for the multicarload transportation of grain in "Big John" hopper cars became a *cause célèbre* before the ICC and in the courts.⁶ Several tariffs for the transportation of grain from the Great Plains states in either trainload or multiple carload lots have also been published. The cost estimates prepared by the railroads initiating these tariffs can be compared with the ICC's estimates of the current costs of transporting grain in carload lots to ascertain the potential significance of this innovation for agriculture in the Great Plains states.

As to the nature and content of the "costs" reported by the ICC, there are two different cost concepts: "out-of-pocket" costs and "fully distributed" costs. Which, if either, of these cost concepts is relevant as a measure of current cost of transporting grain in carload lots for comparison with the cost of transporting grain in trainload lots? Fully distributed cost is clearly unacceptable, because it prorates railroad losses from passenger traffic and less-than-carload shipments to carload-lot shipments. Whatever content we give to the words "grain transport cost," they cannot meaningfully include the losses railroads incur from transporting passengers and less-than-carload traffic!

The ICC's Bureau of Accounts has pointed out [21, p. 3] that its "out-of-pocket" costs are sometimes referred to as added traffic costs, marginal costs, direct costs, assignable costs, separable costs, traced costs, or prime costs. Whatever the term used, the figures have reality in rate making only to the extent that they reflect the added costs which were incurred because the traffic in question was handled, or the costs which could have been avoided if the traffic were not handled." Since the Com-

⁵ An extensive list of innovations in the railroad industry in the last decade or so has been given by Alfred E. Perlman, president of the New York Central Railroad [16, pp. 52-55].

⁶ It took more than four years for the Southern Railway to secure full approval of the proposed reduction in rates on grain in multiple-car lots moving to various southeastern destinations from several different origins along the Ohio and Mississippi rivers. An extensive account of the proceedings before the ICC, the Federal District Court in Cincinnati, and the U.S. Supreme Court has been presented by Nightingale [15, pp. 109-129].

mission's "out-of-pocket" cost is essentially a long-run concept, the relevant question is what would have been the added (avoided) cost of a substantial increment (decrement) of traffic of a particular kind between particular locations at a particular time, given the prior opportunity to adjust the capital, labor, and other resources used in such transportation. So conceived, "out-of-pocket" cost may be a reasonably satisfactory measure of the current "cost" of transporting grain by rail in carload lots.

Among the cost studies prepared by the ICC is the *Distribution of Rail Revenue Contribution by Commodity Groups* for various years.⁷ From the data presented in these studies, it is possible to plot on a scatter diagram the out-of-pocket costs of transporting a ton of wheat, corn, sorghum grain, oats, barley, rye, soybeans, and flaxseed various distances. In the linear regression equation for grain transported within and from the Western District in 1961, the constant term, a , was \$0.3418 and b (the regression coefficient for number of miles) was \$0.0081; the standard error of estimate was \$1.1218 [20]. Thus, the out-of-pocket cost of grain transport per revenue ton-mile fell below one cent for distances in excess of 170 miles. For the median distance of about 800 miles, the out-of-pocket cost per revenue ton-mile was approximately 8½ mills.⁸

The foregoing highly averaged "costs" of grain transport can now be compared with the cost projections of the Soo Line Railroad Company and the Missouri Pacific Company for trainload movements. On March 11, 1964, the Soo Line in conjunction with eight other railroads issued Freight Tariff 526 D for the transportation of wheat by unit train from Duluth, Minneapolis, and St. Paul, Minnesota, and Superior, Wisconsin, to Buffalo, New York. Normal terminal and transit privileges were inapplicable under this tariff, and the customary "free time" of 48 hours to enable the consignee to unload the grain was reduced to 24 hours. Furthermore, the minimum weight per car was, with some exceptions, 55 tons, and the aggregate minimum weight per trainload was 4,950 tons. Finally,

⁷ In this study the computed carload unit costs are applied to a 1-percent sample of carload waybills to determine the out-of-pocket cost of transporting each of 261 commodities or commodity groups into which railroad traffic is classified. For purposes of cost determination, the United States is divided into three territories, Eastern, Southern, and Western, with the last comprising the area west of the Mississippi River. The "costs" of rail transport represent those achieved under average conditions with respect to switching, type of equipment, and empty-return ratio [20, p. 28].

⁸ The out-of-pocket costs of transporting grain within and from the Western District of the United States, as computed here, are of the same order of magnitude as those reported in several other studies. Meyer [12, p. 7] has estimated the *minimal* long-run marginal cost of transporting bulk commodities by rail as 7 mills per revenue ton-mile in 1960 mills, and the Canadian Pacific Railway, in its *Memorandum in Respect of "Results of Cost Study"* (undated, mimeo.), has calculated the variable cost of transporting grain from Western Canada as 7.4 mills per revenue ton-mile as of 1958, and the total cost, excluding passenger deficit, as 10 mills.

each shipment had to take place on a single bill of lading from one origin on a single day to one destination.

A study of out-of-pocket cost of transporting wheat by the Soo Line from Duluth, Minnesota, to Chicago, Illinois, was undertaken by Rychley [18]. He used the cost-finding procedures outlined by the ICC "adjusted to reflect the actual characteristics of the unit train operation involved in this proceeding" [18, p. 1]. A summary of his estimates is given in Table 1.

Table 1. Soo Line Railroad Company estimated out-of-pocket costs on unit grain trains from Duluth, Minnesota, to Chicago, Illinois

Item	Estimated out-of-pocket costs		
	Per car	Per ton ^a	Per ton-mile ^b
Line haul			
Loaded	7,198.519¢	123.899¢	0.279¢
Empty	2,728.296	47.591	0.108
Terminal	1,278.280	22.001	0.049
Interchange switching	309.201	5.322	0.012
Inter- or intra-train switching	34.895	0.428	0.001
Per diem	959.861	16.693	0.038
Loss and damage	520.000	8.950	0.020
Total	13,039.052¢	225.284¢	0.507¢

^a Average number of tons per car, 58.1.

^b Route miles, 444.8.

Source: Soo Line Railroad Company [18].

Rychley's estimate of the out-of-pocket cost per ton-mile of transporting wheat from Duluth to Chicago by unit train is only 57 percent of the typical out-of-pocket cost of moving carload-lot shipments an equal distance within and from the Western District, as computed from the regression equation discussed earlier. Alternatively stated, the out-of-pocket costs of carload-lot grain shipments of about 450 miles under average conditions in the Western District would appear to exceed those in trainload lots from Duluth to Chicago by some 75 percent.

On May 13, 1966, the Missouri Pacific Railroad issued Supplement 12 to Freight Tariff 50-D and Supplement 6 to Freight Tariff 57-E. These tariffs provided for the transportation of wheat, oats, sorghum grain, corn, and rye in 75 or more covered hopper cars with minimum weights of 100 tons each, shipped under one bill of lading on a single day from one origin to one destination. If consignments contained more than one kind of grain, not fewer than 24 carloads had to be of one grain. Finally, no switching charges at origin or destination were to be absorbed by the

Missouri Pacific, and no transit privileges of reconsignment, diversion, or inspection were to be granted. Permitted origins were Omaha, South Omaha, and Nebraska City, Nebraska; Wolcott and Kansas City, Kansas; St. Joseph, Kansas City, and St. Louis, Missouri; and East St. Louis, Illinois. All grain shipments were for export from Baton Rouge, New Orleans, and Port Allen, Louisiana.

Out-of-pocket cost estimates for the transportation by the Missouri Pacific of grain in trainload lots from Omaha, Kansas City, and St. Louis were developed by Pedigo [13]. A summary of his estimates is given in Table 2.

Table 2. Out-of-pocket costs for movement of grain in trainload shipments of 75 covered hopper cars from Omaha (1,201 miles), Kansas City (1,004 miles), and St. Louis (862 miles) to New Orleans

Item	Out-of-pocket cost		
	Omaha	Kansas City	St. Louis
Origin terminal cost per car	\$ 5.54	\$ 3.45	\$ 5.87
Destination terminal cost per car	0.84	0.84	0.84
Interchange switching cost per car	0.78	0.78	0.78
Line-haul cost per car	266.34	222.39	184.42
Freight car expense per car	64.65	56.40	50.46
Total cost per car	338.15	283.86	242.37
Total cost per ton	3.38	2.84	2.42
Total cost per ton-mile	0.00281	0.00283	0.00281

Source: Missouri Pacific Railroad Company [13, Appendix A].

The estimated 2.8 mills out-of-pocket cost per ton-mile of trainload grain shipments from Omaha, Kansas City, and St. Louis to New Orleans is only about one-third of the out-of-pocket cost of typical carload grain shipments from the Western District for equivalent distances. That the Missouri Pacific estimated a greater cost reduction than did the Soo Line is explained by the former's use of high-capacity covered hopper cars, rather than ordinary box cars, with an accompanying increase in the ratio of revenue tons to gross tons.

Under any circumstances, there would appear to be significant opportunities for reduction in the cost of transporting grain wherever the volume moving among various pairs of origins and destinations is of sufficient magnitude to warrant a continuous shuttling of a unit train among these points. So far, application of the unit-train principle to grain movement has been limited to situations in which there is strong competition

by exempt water carriers. When such water competition is not present, the Interstate Commerce Commission is much less likely to look favorably on tariffs which will induce multiple-car shipments, even though in excess of out-of-pocket costs, if the tariffs are less than fully distributed costs and if objections are raised by other railroads, shippers, consignees, or other interest groups.⁹

Internal Economies in Railroad Transport

At first sight, it might appear that technological change and internal economies are largely unrelated. Technological change would be represented, graphically, as a shift in the long-run average-cost curve, whereas the existence of internal economies would be depicted by the downward-sloping portion of the long-run average-cost curve. Technological change, however, can increase or decrease the level of output of the optimum firm, encouraging thereby an expansion or contraction of firm size. Only a few studies of scale economies in railroad transport have been undertaken to date and none, to my knowledge, which relates technological change to changes in the optimum size of railroad enterprises. The very substantial number of mergers proposed and instituted in recent years¹⁰ might suggest the emergence of new scale economies, but it could also be due to increased intermodal competition; to more aggressive railroad managements; to the desire to eliminate what little inter-railroad competition still exists; to the hope that merger will facilitate the abandonment of low-traffic-density branch lines which should be abandoned anyway, with or without merger; to the expectation that it will increase the amount of interchange traffic (or forestall the loss thereof); and to a changed regulatory environment.

Under any circumstances, if there are unrealized economies of scale in railroad transport, whether attributable to recent innovations or not, there are opportunities to effect further reductions in the cost of railroad transport. Let us review the two most extensive studies of scale economies in the railroad industry.

Borts stratified 61 railroads by region (Eastern, Southern, and Western) and by size (large, medium, and small) to test the hypotheses "that the cost-output relation is significantly affected by the size of the firm and that it is significantly affected by the region in which it operates" [5, p. 120]. As to the long-run cost characteristics in the three regions,

⁹ A number of protests were entered against the Missouri Pacific Railroad's unit grain train freight tariffs. Had not unregulated barge traffic been a crucial factor in the justification, it seems likely that the ICC would have suspended the rates pending an investigation.

¹⁰ Since 1955, no fewer than 50 merger applications have been submitted to the ICC by American railroads. Of these, 30 have been approved, 6 denied, 4 withdrawn, and 1 dismissed, and 9 are still awaiting ICC disposition [1, p. 2].

Borts makes the following observations:

The average cost per car-mile . . . shows sharply different behavior in the Eastern region on the one hand and the Southern and Western regions on the other. There is evidence of long-run increasing cost in the Eastern region and long-run constant or decreasing cost in the South and West. In the East, average cost is higher for the largest size firm than for the smallest. . . . In the South and West, on the other hand, either the average cost is highest for the smallest size firm, or else the average cost doesn't vary by size of firm [5, pp. 126-127].

Healy analyzed the effects of traffic density and of scale on the performance of 37 railroad systems in the United States during the period 1954-1956. Although he found little correlation between traffic density and railroad efficiency in the Eastern and Southern regions, the Western region presented a different picture:

For Western systems up to but not including those of very highest traffic density the analysis indicates that capital requirements, wages, and transportation (train, yard and station operations) expense per unit of composite output all decline with increasing density while rate of return on capital increases. . . . There is no relation between density and any of the measures of performance . . . for the entire sample regardless of region at densities of over \$50,000 annual revenue per mile of road [8, p. 2].

After eliminating the effects of differences in density, Healy found that railroad systems with 5,000 to 19,000 employees had lower capital-output ratios than those with 2,000 to 5,000 employees or those with more than 19,000 employees. He also found that railroads with more than 10,000 employees experienced increases in wages and transportation expense per unit of output [8, p. 3].

The implications of his findings on traffic density were explored by Healy in his 1962 article:

In the Prairie region the variegated pattern of system main lines is so complicated as to defy summarization, but some highlights are indicative. None of the main routes east from Denver anywhere nearly met the minimum density. Only half of the main lines east of a line going from St. Paul to Omaha to Kansas City met it, several falling far short. . . . In general it appears that the clear-cut gains from reducing parallel main lines by means of merger lie principally in the area between the Rockies and the Mississippi River and in connection with the trans-mountain routes in the Northwest [9, pp. 438-439].

While neither the Borts nor the Healy study is favorable to a wholesale merger of railroad systems, particularly in the Northeastern part of the country, Borts's work does suggest that, at the very least, mergers could generally be effected in western United States without incurring diseconomies of scale. On the basis of Healy's more carefully drawn sample and twofold measure of size (traffic density and employment) it would appear

that railroad efficiency in the Great Plains area could be enhanced through the merger of parallel lines, provided that the consolidated system is not permitted to grow to the point where diseconomies of scale (as measured by number of employees) exceed the economies achieved through increased traffic density.¹¹

Railroad Efficiency and the Economy of the Great Plains

One of the most promising innovations in the railroad industry in recent years is the unit train. Admittedly, much additional research is needed to determine the feasibility of multiple-carload grain shipments and their effect on the economy of the Great Plains. The farm value of grain in the Northern Plains states alone (North and South Dakota, Nebraska, and Kansas) in 1966 was \$1.75 billion, or 44 percent of all farm marketings in the Northern Plains states and 21 percent of the farm value of grain for the United States as a whole [19, pp. 618 and 639-642]. Since the Great Plains states are located greater distances from the major consuming areas than are other grain-growing areas, reduction in transportation costs should confer differential advantages upon them. It would appear that the most likely outcome of a more widespread adoption of unit-train grain shipments from the Northern Plains states would be the following:

1. An increase in the size of the area of profitable grain shipment. (Some 84 percent of rail grain shipments from the Northern Plains states is now destined for the six neighboring states of Minnesota, Missouri, Texas, Louisiana, Iowa, and Wisconsin [22]; reductions in transport costs should open new markets located at greater distances.)

2. A reduction in the ratio of processed grain to raw grain shipments. (Currently, processed grain shipments are running about 18 percent—by weight—of raw grain shipments from this area [22]; presumably, a reduction in the relative cost of transporting grain would have an adverse effect upon grain-processing activities in the Northern Plains states.)

3. A greater concentration of storage facilities in the Plains states. (Unit-train economies can be realized only if shipments of grain are regularized; in view of the irregularity of grain production, regularity of shipment presupposes the location of storage facilities at points of origin.)

4. An increase in the Plains states' share of the farm value of grain for the United States as a whole. (Although a reduction in the relative cost of producing grain in the Plains states should lead to an increase in grain output in these states at the expense of grain-growing areas nearer to the

¹¹ Healy suggests that one possibility of avoiding this dilemma is abandonment of one of the lines and joint operation of the remaining line by the otherwise independent railroads [8, p. 5].

principal consuming markets, such an outcome depends more on policy decisions than on reasonably predictable economic forces.)

Although railroads have been the beneficiaries of technological change, particularly in the last decade or so, a low rate of return has served to limit both the internal and the external sources of capital necessary for modernization. In 1956, John W. Barriger, president of the Pittsburgh and Lake Erie Railroad, estimated that it would require \$12.5 billion in capital expenditures for roadway and \$7.5 billion for equipment (at 1954 prices) between 1956 and 1963 or 1965 to achieve modernization of the Class I railways of the United States [4, p. 71]. As of the end of 1965, the cumulative capital expenditures, in 1954 dollars, by Class I railroads for the preceding decade were just over \$2.6 billion for additions and betterments to roadways and just under \$7.0 billion for equipment. The total was less than half that which Barriger considered necessary.

If the comparative rates of return for different modes of transport in recent years had reflected their relative social costs, the limited ability of railroads to secure new capital would be consonant with an optimum allocation of resources. There are, however, a number of institutional factors which have served to depress the rate of return in the railroad industry relative to other transport modes, thereby preventing the capital market from allocating funds in accordance with underlying marginal efficiencies. Among these adverse institutional factors should be included (1) a discriminatory rate structure which has diverted profitable railroad traffic to highway carriers and left undisturbed the least profitable or unprofitable traffic; (2) a regulatory policy which has made it difficult for railroads to "slough off" unprofitable passenger traffic and branch lines; (3) subsidies of greater or lesser magnitude to rival modes of transport, with the exception of the pipelines; (4) work rules which have made it difficult for railroads to adjust the size and composition of the work force in response to changes in technology; and (5) centralized assessment of railroad property which has served to discriminate against railroads in comparison with property subject to local assessment. The rectification of these policies should raise the expected rate of return in the railroad industry to the point where capital funds could be secured for innovations which would permit railroads to transport goods at lower social costs than rival modes of transport.

The recapture of traffic by the railroads through the institutional modifications referred to above and through a more rapid and extensive spread of new techniques would also have the virtue of increasing traffic density per road mile. While this would be of little advantage, generally, to the eastern, southern, and far western roads, it would, apparently, reduce the costs per unit of output for the railroads traversing the Great Plains area. Conceivably, increases in traffic density, induced by corresponding rate

reduction,¹² could render the merger of parallel lines in this area unnecessary, or even undesirable.

Given the opportunity to expand output in conformity with changes in the relative cost of transporting products to the principal consuming markets, agriculture could be a major beneficiary of improvements in railroad efficiency in the Great Plains states. New techniques, particularly the unit train; the elimination of discriminatory practices and of institutional restraints on efficiency; and judicious mergers—all could contribute to this objective. Any quantitative appraisal of the potential impact of realizable reductions in rail transport costs upon the economies of the Great Plains states, however, must await a good deal more research.

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¹² Railroad costs, of course, are not necessarily good predictors of railroad rates. I have discussed elsewhere [7, pp. 68–69] the managerial and regulatory changes necessary to insure reasonably close conformity between railroad rates and long-run marginal costs.

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Statistical Analysis of Identities in Random Variables*

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A random variable of economic interest is sometimes an identity function of two or more separate variables; for example, crop income per acre is the product of price and yield. This article presents a method for partitioning the variance of such a random variable into components that can be associated with the separate random variables in the identity and interactions among them. Under some statistical assumptions on the variables involved, the converse of the partitioning procedure is useful for deriving the variance of a random variable from the moments of the separate variables of the identity.

SEVERAL studies in agricultural economics have encountered the following type of problem. A measure of economic interest is a function of two or more random variables, and the function holds for all values of the variables; that is, it is an identity. The functional form is usually specified by definition; for example, gross income per acre from a crop is the product of price and yield. The analyst is interested in decomposing the variance of the function into components attributable to each variable. Let the function be $f(x_1, x_2)$. Then the question is, What proportion of the variance of $f(x_1, x_2)$ can be associated with each variable x_1 and x_2 ?

Let us first consider a multiplicative relationship that has received attention in the literature. Crop production is identically the product of yield and acreage; that is,

$$(1) \qquad y = x_1 x_2,$$

where y , x_1 , and x_2 are production, acreage, and yield, respectively. This particular identity has been analyzed many times because it has policy implications for production controls and sheds light on the sources of farm production changes [1, 5, 6, 7, 8, 10, 13]. The two earliest methods, based largely on intuitive measures, are outlined by Sackrin, who discards them in favor of a third [8]. Sackrin proposed taking logarithms of both sides of the identity to reduce it to an additive relation:

$$(2) \qquad y' = x_1' + x_2',$$

* Missouri Agr. Exp. Sta. J. Ser. No. 5329. We are deeply indebted to an anonymous reviewer for the *Journal*, who informed us of the early work of Sewell Wright on partitioning coefficients of separate determination from multiple regression into direct and indirect components. The reviewer also brought to our attention discussions of the same problem by Mordecai Ezekiel and Henry Schultz.

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where primes denote logarithms of the respective variables. Then his suggestion was to make two separate simple regressions, using y' as the independent variable and each x_1' and x_2' as the dependent variable. The algebra is such that the sum of the two simple regression coefficients is unity, and Sackrin proposed that these coefficients be used as relative measures of the contribution of yield and acreage to variation in production. In order to remove influences of trend or to get year-to-year changes, Sackrin used first differences of logarithms in the time series. Essentially this same method was used by Swanson [10] and Finley [5].

Although it may not be apparent, the relative measures recommended by Sackrin are essentially the "coefficients of separate determination" used by Swanson and West to analyze feeder cattle returns [11]. The coefficient of multiple determination in a linear identity equals unity and so does each of the regression coefficients associated with the multiple regression. As a consequence, the simple regression coefficient associated with the regression of each independent variable on the dependent variable is a coefficient of separate determination.¹

There are two objections to Sackrin's method of analysis: (1) the analysis is on the logarithm of production instead of production itself, and (2) interaction effects between acreage and yield are not given consideration. Little need be said about the first shortcoming except that interpretation of results is greatly complicated. The second deficiency arises from the general problem of interpreting coefficients of separate determination [4, p. 382; 9, p. 742; 14]. Sackrin's decomposition procedure does not adequately recognize statistical dependence between acres and yield, and it is possible to get results even with one coefficient negative and the other positive. We will return to this problem later when dealing with linear identities as a special case of more general relations.

The critical question is whether there is a sound logical basis for using correlation and regression methods on this particular problem. It would appear that regression methods have been used on this problem primarily through reasoning by analogy with conventional uses and interpretations of regression. Although reasoning by analogy is fruitful in getting ideas for

¹ Consider the multiple regression of y on two independent variables, x_1 and x_2 , with all three variables transformed to deviations from their respective sample means. Then the coefficient of multiple determination is

$$R^2 = b_1 \frac{\sum x_1 y}{\sum y^2} + b_2 \frac{\sum x_2 y}{\sum y^2},$$

where b_1 and b_2 are the coefficients of the multiple regression. The coefficients of separate determination for variables x_1 and x_2 are the first and second terms, respectively, of the above formula. However, the ratios $\sum x_1 y / \sum y^2$ and $\sum x_2 y / \sum y^2$ are the simple regression coefficients associated with regressing x_1 and x_2 , respectively, on y . Therefore, in a linear identity where $R^2 = b_1 = b_2 = 1$, these simple regression coefficients are also coefficients of separate determination.

approaching a problem, it can also be deceiving if not tested rigorously. Since relation (1) is an exact relationship holding for each observation, and not merely in the mean, is there any reason to expect regression methods to be applicable? Even if the relation is additive, as in (2), there is no need for regression analysis to estimate parameters.

A Series Expansion Method

Relation (1) can be written as a Taylor's series expansion [3, p. 80] about the means of x_1 and x_2 , and this expansion leads to a method of decomposing the variance of production into acreage and yield components. The method is quite general and can be applied to functions of any number of variables; the only restriction is that the function can at least be approximated by a few terms of the Taylor's series expansion. For example, it could be used to break crop income into price, yield, and acreage elements. The nice thing about a product relation in two variables is the simplicity of the Taylor's expansion.²

The series expansion for (1) is

$$(3) \quad y = \mu_1\mu_2 + (x_1 - \mu_1)\mu_2 + (x_2 - \mu_2)\mu_1 + (x_1 - \mu_1)(x_2 - \mu_2),$$

where μ_1 and μ_2 denote the means of x_1 and x_2 . Taking the expectation of both sides of (3), we get

$$(4) \quad E(y) = \mu_1\mu_2 + \text{Cov}(x_1, x_2),$$

where E is used to denote the expectation operator. Using (4) and (3), we find that the variance of y is

$$\begin{aligned} \text{Var}(y) &= E[y - E(y)]^2 \\ &= E[(x_1 - \mu_1)\mu_2 + (x_2 - \mu_2)\mu_1 \\ &\quad + (x_1 - \mu_1)(x_2 - \mu_2) - \text{Cov}(x_1, x_2)]^2, \end{aligned}$$

² Taylor's formula for a two-variable function $f(x_1, x_2)$ at the point (μ_1, μ_2) is

$$\begin{aligned} f(x_1, x_2) &= f(\mu_1, \mu_2) + (x_1 - \mu_1) \frac{\partial f}{\partial x_1} + (x_2 - \mu_2) \frac{\partial f}{\partial x_2} \\ &\quad + \frac{1}{2} (x_1 - \mu_1)^2 \frac{\partial^2 f}{\partial x_1^2} + \frac{1}{2} (x_2 - \mu_2)^2 \frac{\partial^2 f}{\partial x_2^2} \\ &\quad + (x_1 - \mu_1)(x_2 - \mu_2) \frac{\partial^2 f}{\partial x_1 \partial x_2} \\ &\quad + (\text{higher order terms}), \end{aligned}$$

with the understanding that all partial derivatives are evaluated at $x_1 = \mu_1$, $x_2 = \mu_2$. When $f(x_1, x_2) = x_1x_2$ as in (1), the only nonzero partial derivatives are

$$\frac{\partial f}{\partial x_1} = x_2, \quad \frac{\partial f}{\partial x_2} = x_1, \quad \frac{\partial^2 f}{\partial x_1 \partial x_2} = 1,$$

and it is obvious that the general formula reduces to (3).

which by writing out the square can be reduced to

$$\begin{aligned}
 \text{Var}(y) = & \mu_2^2 \text{Var}(x_1) + \mu_1^2 \text{Var}(x_2) + 2\mu_1\mu_2 \text{Cov}(x_1x_2) \\
 & + E[(x_1 - \mu_1)(x_2 - \mu_2) - \text{Cov}(x_1, x_2)]^2 \\
 (5) \quad & + 2\mu_1 E(x_1 - \mu_1)(x_2 - \mu_2)^2 \\
 & + 2\mu_2 E(x_1 - \mu_1)^2(x_2 - \mu_2).
 \end{aligned}$$

The first two terms of (5) are the direct effects of x_1 and x_2 , and the third term is a first-order interaction effect. The fourth term is the variance of the covariance product about the covariance parameter, is necessarily positive, and is neutral for purposes of interpretation. The last two terms are higher-order interactions. Since these last three terms have their origin in the second-degree terms of the Taylor's series, we would expect them to be relatively unimportant, but in some sets of data they might give trouble.

Our concern with only the *relative* contribution of x_1 and x_2 to the variance of y lets us give less attention to the higher-order terms than would be permissible in some applications. Each interaction term implies an influence on the variance that cannot be decomposed into separate effects for each variable x_1 and x_2 , no more than feed eaten by a sheep can be logically divided into separate portions for wool and mutton production. However, we would expect the first interaction term, $2\mu_1\mu_2 \text{Cov}(x_1, x_2)$, to dominate the higher-order terms in most situations. Should this conjecture prove correct empirically, interpretation of results would be much simpler than the complete formula in (5) would suggest.

Division of equation (5) by the variance of y normalizes the terms on the right-hand side so that they sum to one, but the presence of negative terms makes interpretation difficult. Therefore, we suggest dividing by the sum of the first two terms (direct effects of x_1 and x_2) of (5), and then using the first three terms. The result is

$$(6) \quad \frac{\mu_2^2 \text{Var}(x_1) + \mu_1^2 \text{Var}(x_2) + 2\mu_1\mu_2 \text{Cov}(x_1, x_2)}{\mu_2^2 \text{Var}(x_1) + \mu_1^2 \text{Var}(x_2)} = p_1 + p_2 + p_{12},$$

where each term in the latter expression is the respective numerator term divided by the denominator in the fraction written above.

Both p_1 and p_2 are positive and sum to unity, while the interaction or covariance term can be of either sign. We are assuming that the three terms from (5) that were omitted are small relative to those included in (6). Primary interest is in p_1 and p_2 , because these can be interpreted as net effects directly attributable to x_1 and x_2 , respectively, after compensating for the statistical interrelations in the two variables. Nevertheless, the interaction terms are by definition additive components in the variance and must be considered in many applications, but very likely the one relative term p_{12} will dominate the interaction effects. Strict independence of x_1 and x_2 would

imply all terms zero except p_1 and p_2 . Also, if x_2 were held fixed at its mean, the variance of y would equal $\mu_2^2 \text{Var}(x_1)$; and likewise if x_1 were held fixed at its mean, the variance of y would equal $\mu_1^2 \text{Var}(x_2)$. Thus, the standardization suggested for interpretation is quite straightforward.

Depending on the purposes underlying the analysis, it might be necessary to focus on variance about a trend line or even a more complex trend function. In such cases, the random variables contain time as a parameter in their density functions, and the Taylor's expansion of $y = x_1 x_2$ is about the means $\mu_1(t)$ and $\mu_2(t)$. Since applications will use sample observations as the random variables, the trend will enter at integer values on the time variable. The method of estimating trend is of no consequence for present discussion; the trend estimate is taken as given, and the methods presented here are then applied. The only complexity introduced by trend is that our measures p_1 , p_2 , and p_{12} become functions of time, since they each include one or both means $\mu_1(t)$ and $\mu_2(t)$. Of course, the ordinary assumption used in estimating trend is constant variance over the course of time; that is, the variances of x_1 and x_2 remain constant.

The assumption that the variances of x_1 and x_2 remain constant does not imply that the variance of y is constant. In fact, equation (5) makes it obvious that for μ_1 and μ_2 , changing through time, the variance of y is not likely to remain constant. Therefore, usual methods of trend estimation are dubious when applied directly to a product relation such as income per acre. This problem was recognized by Carter and Dean [2] in applying the variate difference method [12] to income per acre; and they also pointed out that the systematic and random components of income are not independent if price and yield are assumed to fit the variate difference method model [2, p. 218]. However, Carter and Dean apparently overlooked the alternative of computing variance of income directly from the relationships derived for prices and yields.

After one estimates the trend or systematic parts of yield and price variances, there are two ways of estimating variance of income per acre around the trend. One way would be to use relation (5), recognizing the means μ_1 and μ_2 as functions of time, and compute the separate terms from moments of x_1 and x_2 . The other way would be to use (4) to compute the mean of income, again recognizing the means as dependent on time, and compute the variance directly from the income observations. To be more explicit, the latter method would use

$$(7) \quad E(y | t) = \mu_1(t)\mu_2(t) + \frac{1}{N} \sum_{i=1}^N [x_{1i} - \mu_1(t)][x_{2i} - \mu_2(t)]$$

to estimate mean income, where x_1 is now price, N is the number of years in the time series, and $\mu_1(t)$ and $\mu_2(t)$ are the systematic components of price

and yield, estimated as linear trends or more complex functions. Then the variance of y about the mean is given by

$$(8) \quad \text{Var}(y) = \frac{1}{N} \sum_{t=1}^N [y_t - E(y|t)]^2,$$

with $E(y|t)$ defined by equation (7).

If one wished to decompose income variance into components for price, yield, and acreage, the approximate variance formula for the three-variable product would be

$$(9) \quad \begin{aligned} \text{Var}(x_1 x_2 x_3) \simeq & \mu_2^2 \mu_3^2 \sigma_{11} + \mu_1^2 \mu_3^2 \sigma_{22} + \mu_1^2 \mu_2^2 \sigma_{33} \\ & + 2\mu_1 \mu_2 \mu_3^2 \sigma_{12} + 2\mu_1 \mu_2^2 \mu_3 \sigma_{13} \\ & + 2\mu_1^2 \mu_2 \mu_3 \sigma_{23}, \end{aligned}$$

where σ_{ij} denotes $\text{Cov}(x_i, x_j)$ and, if $i=j$, denotes $\text{Var}(x_i)$. Relation (9) was derived by saving only first-order terms of the Taylor's series expansion. This relationship could be standardized for interpretation by dividing it by the sum of its first three terms, thus yielding three positive direct effects summing to unity and three interaction effects, each of which could have either sign. Some or all of the means in (9) could be estimated as functions of time but, to simplify the notation, were not written explicitly with time as an argument. Purposes of the research would dictate which variables should have their means expressed as functions of time.

Initial discussion of feeder cattle returns by Swanson and West began with an additive identity that divided returns into "gain per head on price spread" and "return due to feeding margin." This identity could be partitioned by the same approach as used in the preceding multiplicative functions, except that it would be even simpler. Expansion of the linear function by series in the proximity of the means yields the familiar formula for the variance of a sum. Thus, for the identity

$$(10) \quad y = x_1 + x_2,$$

we have

$$(11) \quad \text{Var}(y) = \text{Var}(x_1) + \text{Var}(x_2) + 2 \text{Cov}(x_1, x_2).$$

Dividing relation (11) by the sum of the variances of x_1 and x_2 would give a standardized form for interpretation. With regard to the problem addressed by Swanson and West, the covariance term would quantify the extent to which feeding skills and marketing finesse are associated in management.

Sackrin's logarithmic transformation of production gives equation (10) with all variables expressed in logarithms, and equation (11) could be used for decomposition of the variance of the logarithm of production. However, one still faces the problem of interpretation in going from the logarithm of

production to actual production. Therefore, there seems to be an advantage in using equation (5) directly on production rather than going through a logarithmic transformation.

Equations (10) and (11) suggest that as an alternative to "coefficients of separate determination" used in multiple regression analysis one might view the sample regression coefficients as given and derive measures from the following equation:

$$(12) \quad y = b_0 + b_1x_1 + b_2x_2 + e,$$

where b_0 , b_1 , and b_2 are multiple regression coefficients and e is the random error. Assumptions of the regression model imply that e is independent of x_1 and x_2 , and the algebraic definitions of b_1 , b_2 , and e make sample covariances of e with x_1 and x_2 equal to zero. Thus, we have

$$(13) \quad \begin{aligned} \text{Var}(y | b_0, b_1, b_2) &= b_1^2 \text{Var}(x_1) + b_2^2 \text{Var}(x_2) + \text{Var}(e) \\ &\quad + 2b_1b_2 \text{Cov}(x_1, x_2). \end{aligned}$$

A proportion measure for each x_1 , x_2 , and e can be obtained by dividing (13) by the sum of the variances of these three sources. The sample error variance is the error sum of squares, from the multiple regression, divided by N . The method has an intuitive advantage over coefficients of separate determination in that consideration is given to covariances among the independent variables. Also, in the special case where x_1 and x_2 are orthogonal, this partition reduces to using the simple r -squares between y and each independent variable as relative measures of the contribution of each x_1 and x_2 to the variance of y .

However, the complete interpretation and further decomposition of coefficients of separate determination as presented by Wright [14], and later by Ezekiel [4, p. 382] and Schultz [9, p. 742], gives essentially the same results as the foregoing analysis.³ In fact, the coefficients of separate determination can be shown to equal

$$(14) \quad \begin{aligned} &[b_1^2 \text{Var}(x_1) + b_1b_2 \text{Cov}(x_1, x_2)]/\text{Var}(y) \quad \text{and} \\ &[b_2^2 \text{Var}(x_2) + b_1b_2 \text{Cov}(x_1, x_2)]/\text{Var}(y), \end{aligned}$$

where the variances and covariances are sample moments. The same mea-

³ It appears that Wright had in mind essentially the same approach as that used here to cope with a multiplicative relationship in the independent variables. This conjecture is based on his analysis of a product relation [14, p. 563] and his statement, "It is also easy to show that the formulae apply approximately for multiplying factors" [14, p. 567]. Wright does not give an explanation of his formula on page 563 for the variance of a product relation in two variables, but his formula is the same as (5) except that the last two terms of (5) are missing. (Wright's assumption that the correlation between the two variables is zero automatically removes the third term of (5) containing $\text{Cov}(x_1, x_2)$.) A likely explanation of Wright's formula is erroneous derivation of the product relationship from a series expansion.

tures in the common notation of regression are

$$(15) \quad \begin{aligned} &\beta_1^2 + \beta_1\beta_2r_{12} \quad \text{and} \\ &\beta_2^2 + \beta_1\beta_2r_{12}, \end{aligned}$$

where β_1 and β_2 are the standardized regression coefficients commonly called "beta coefficients" and r_{12} is the simple correlation between variables x_1 and x_2 . The equality of (14) and (15) follows directly from the algebra of multiple regression.

In view of these relations, researchers should heed the caution given by Schultz:

The indirect or joint effect of any two independent variables is distributed equally between them. This should put us on our guard against an uncritical acceptance of the results yielded by the coefficients of determination. In the absence of a theory of the interrelations to be expected among our variables, the coefficients of determination might be quite misleading [9, p. 742].

The situation is comparable to utilizing the methods presented earlier for decomposition of identity functions in random variables. All interaction terms are jointly determined by at least two variables, and the magnitude and sign of such an interaction term is determined by the interrelationships existing among its variables.

An Illustration of the Method

An application of the method described here for partitioning the variance of crop production is summarized in Table 1. The analysis in part A of the table used total variance; that is, trend equations were not estimated for

Table 1. Decomposition of crop production variance, time series data: 1921-1963 for corn, wheat, and cotton; 1936-1963 for soybeans^a

Crop	Direct effects		Linear inter- action (3)	Quadratic acreage times quadratic yield (4)	Linear acreage times quadratic yield (5)	Linear yield times quadratic acreage (6)	Relative error of linear approximation (7)
	Acres (1)	Yield (2)					
<i>Part A</i>							
Corn, Mo.	0.2656	0.7344	-0.5178	0.0342	-0.1723	0.0189	0.3285
Corn, U.S.	.1473	.8527	-.6349	.0357	-.2422	.0849	0.4995
Wheat, Mo.	.4693	.5307	-.2947	.0459	-.0526	-.2161	0.4619
Wheat, U.S.	.2753	.7247	-.2623	.0147	-.1355	.0204	0.1576
Soybeans, Mo.	.8393	.1607	.5691	.0742	-.0435	-.0069	0.0150
Soybeans, U.S.	.9438	.0562	.3669	.0181	.0083	.0857	0.0758
Cotton, Mo.	.3788	.6212	.0485	.0141	-.0238	-.0845	0.0987
Cotton, U.S.	.4613	.5387	-.7821	.0579	-.0690	-.0011	1.061
<i>Part B</i>							
Corn, U.S.	.2763	.7237	-.4891	.0054	-.0871	.0377	0.0943
Wheat, Mo.	.9012	.0988	.1137	.0128	-.0123	-.0443	0.0410
Cotton, U.S.	0.9290	0.0710	-0.0341	0.0240	0.0108	-0.0267	0.0083

^a Column headings 1 through 6 refer to equation (5) and are ordered left to right in the same sequence as the separate terms of the equation.

acreage and yield. We intended our illustrative examples to portray the most adverse conditions for using the method. The systematic changes in specific crop acreages and yields introduce large higher-order interactions which are difficult to interpret. However, the standardization procedure suggested and stated explicitly by equation (6) works well even under these conditions.

The first three columns of Table 1 are the relative measures p_1 , p_2 , p_{12} from (6), with the sum of columns one and two equal to unity. The next three columns are the higher-order terms that were excluded from (6); they are standardized by the same divisor as used in (6). Column four was included primarily for completeness, since it is neutral in the decomposition of production variance into acreage and yield effects. Columns five and six are higher-order interactions, and our primary concern is that they not dominate the simplest interaction term, p_{12} , given in column three. Scanning Table 1, part *A*, the reader will see that the higher-order interactions do not appreciably alter the practical evaluation of the influence of acreage-yield interactions on production variability as measured by p_{12} in column three.

Column seven is the relative error in production variance when computed by the first three terms of (5), that is, the linear terms of the Taylor's series expansion. Specifically, column seven is

$$| \text{Var}(y) - [\mu_2^2 \text{Var}(x_1) + \mu_1^2 \text{Var}(x_2) + 2\mu_1\mu_2 \text{Cov}(x_1, x_2)] | / \text{Var}(y).$$

It is comforting that the relative measures of (6) are essentially complete even when the absolute error is quite large. For example, the error for U. S. cotton is as large as the variance, and yet the relative measure p_{12} provides an excellent indication of the interaction effects.

The three cases of largest error in variance estimation from using only the linear terms of the series expansion were selected for further analysis. One of these, wheat production in Missouri, had a high second-order interaction term approaching the magnitude of p_{12} .

Trend lines were fitted to each acreage and yield for each of these three sets of data, and the variance components about the implied trend function for production are listed in Table 1, part *B*. Variances were computed with means at the trend values in 1963, the last year in the data.

Inspection of the results in Table 1, part *B*, shows the improvement that can be expected in the method when one uses deviations from a trend function, that is, when one looks at year-to-year variation. Even the absolute error in variance estimation which results from using only the first three terms of (5) is very small. For example, compare the error (column 7) for U. S. cotton production in parts *A* and *B* of Table 1. The error is also greatly reduced for the other data, although not so dramatically.

In closing, we remind the reader that the six terms of (5) provide all the information that exists about the influence of x_1 and x_2 on the variance of y ,

Appendix Table. Components of production variance^a

Crop	Direct effects		Linear inter-action	Quadratic acres times quad-ratic yield	Linear acres times quad-ratic yield	Linear yield times quad-ratic acres	Total variance ^b	Linear approxima-tion to variance	Relative error of linear approxi-mation
	Acres	Yield							
Corn, Mo.	1,331	3,682	—	172	—	864	1,820	2,417	0.3385
Corn, U.S.	199,101	1,152,232	—	48,277	—	327,322	329,042	493,392	0.4995
Wheat, Mo.	105.0	118.7	—	10.3	—	11.8	107.9	157.7	0.4619
Wheat, U.S.	20,438	53,813	—	1,093	—	10,062	47,319	54,775	0.1576
Soybeans, Mo.	230.7	44.2	—	20.4	—	11.9	437.9	431.3	0.0150
Soybeans, U.S.	25,166	1,499	—	482	—	221	39,439	36,450	0.0758
Cotton, Mo.	5,454	8,943	—	203	—	343	13,738	15,094	0.0987
Cotton, U.S.	25,563,000	29,851,000	-43,341,000	3,210,000	-9,362,000	—	5,858,000	12,074,000	1.0610

^a Production units are millions of bushels, except for cotton, which is thousands of 500-pound bales. Acres are in thousands.

^b Figures may differ from total for first six columns as a result of rounding error.

and our concern with eliminating the last three terms is merely for convenience in interpretation. Thus, the six standardized terms presented in Table 1 provide a complete partitioning of the production variances into components of relative measure. However, we hope that we have presented a good case for focusing on only the first three components, p_1 , p_2 , and p_{12} , for practical interpretation.

Appendix

The appendix table of variance components for production of each crop is provided for the interested reader. These data were the source for computation of Table 1, part A, in the text. The row for U. S. cotton production is of particular interest because it lets one see how, even if the error in the linear approximation is large, the relative measures p_1 , p_2 , and p_{12} can quite accurately portray the contribution of acres, yield, and acre-yield interactions, respectively.

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EDITOR'S NOTE: This section of the *American Journal of Agricultural Economics* may include comments on and replies to previous articles and other literature in agricultural economics, suggestions for improving the effectiveness of the AAEA, discussions of changes in emphasis needed within the profession, and contributions on other topics of interest and importance to agricultural economists. Manuscripts submitted for this section should be prepared in accordance with the guide appearing on the inside of the back cover of this issue and should not exceed 1,000 words.

Communications

LABOR MOVEMENTS BETWEEN FARM AND NONFARM JOBS: COMMENT

The conclusions reached by Brian Perkins and Dale Hathaway [4], based on a sample of social security employment records, are interesting and significant.¹ The authors suggest that "increasing the gross outmovement [from farming] would not appear necessary. Policies are needed which will enable a higher proportion of those who do leave farming to be retained in the nonfarm economy" [4, p. 5].

The main point that I wish to make here is that, under the Perkins-Hathaway definitions, social security statistics may fail to differentiate actual movements between farm and nonfarm jobs from purely statistical changes that do not represent job mobility. Misinterpreting such statistical changes as true intersector movements would tend to overestimate actual "outfarm" and "infarm" mobility and could lead to the "wrong" policy decisions.

The authors define the farm labor

force "to include all persons in the Social Security sample who had coverage from farm employment in that year." Persons employed in agriculture were further classified as "farm operators"² or "farm laborers." Three additional definitions used are as follows: (1) "Persons whose [social security] coverage in a given year was exclusively in nonfarm employment were classified as being in the nonfarm sector"; (2) "those who had no covered employment in the given year were excluded from the labor force of both sectors in that year"; and (3) "employment changes from the farm sector in one year to the nonfarm sector in the next year were referred to as off-farm mobility, and the reverse movement as in-farm mobility" [4, p. 8].

Disconcerting questions arise on these definitions since social security data for any given year clearly ex-

¹ The bulletin received an American Farm Economic Association award for published research, 1967.

² Actually the farm operator class also includes others, such as landlords who participate in the management or the production of crops or livestock on their farms.

clude many of those with farm earnings.³ In 1959, the latest year for which data were included in the Perkins and Hathaway bulletin,⁴ 3.7 million individuals reported farm income to Internal Revenue Service as sole proprietors or farm partners [6, pp. 28 and 58], but only about 2.2 million persons reported farm self-employment earnings for social security [5, p. 6].

Farm self-employment earnings are reported as part of the federal income tax return. Therefore, differences in numbers reporting are due largely to differences in reporting requirements. Persons with gross income from all sources of \$600 (\$1,200 for those 65 or older) or more must file a federal income tax return. But farm self-employment earnings are reported for social security when net farm profit is \$400 or more. Individuals may also report under the gross income option if their gross farm income is \$600 or more. When an individual's wages exceed the ceiling on taxable earnings, only his wages are reported.⁵

Individuals often report farm income irregularly for social security.⁶ This irregular reporting could result from their changing from farm employment to another occupation, as

Perkins and Hathaway conclude. However, individuals might also continue their farming interests but report only nonfarm income. For example, a decline in farm self-employment earnings from more than \$400 to less than \$400 would be interpreted as a farm-to-nonfarm movement for individuals with nonfarm wages covered by social security. No change in nonfarm wage income would be necessary.

Farm profits of \$400 or less are not so low as to be unimportant. As late as 1963, nearly 450,000 individuals, excluding partners, reported net farm profits of less than \$400, and 1,094,000 reported net farm losses for federal income tax purposes [7, pp. 80-81]. These two groups included nearly half those with farm self-employment income.

The gross income option used by as many as 560,000 persons in 1956 can also contribute to the observed "in" and "out" movement from farming. By using the option, many individuals with low self-employment income have a choice of reporting or not [5, p. 28].

Farm landlords, in effect, also have an option which could influence apparent "infarm" and "outfarm" movements when there is essentially no change in the individual's farm situation. Landlords who "materially participate" are required to report self-employment earnings of \$400 or more from farming. However, by not meeting the material participation definition, a landlord who may already be entitled to social security benefits or have coverage in nonfarm employment can choose not to report for social security. A simple change in his farm lease—but not necessarily in farm income—could shift him out of

³ This and other important limitations of the data are discussed in a publication referred to by Perkins and Hathaway in a footnote [3].

⁴ The authors included additional years in a more recent paper [2].

⁵ The maximum earnings which could be taxed were \$4,200 from 1955 through 1958; \$4,800 from 1959 through 1965; and \$6,600 beginning in 1936.

⁶ A distinction should be made between irregular reporting of farm income and the intermittent reporting of combined farm and nonfarm income discussed by the authors [4, pp. 10-11].

the Perkins-Hathaway farm sector. And if he had wages, he could easily be classed as an "off-farm mover."

Fluctuations in off-farm wage income from more to less than the maximum taxable income could also cause irregular reporting even though the individual's farm situation was unchanged. Also, the 1959 change in maximum income to be taxed for social security probably resulted in a few people's being reported as infarm movers even though the change was again largely statistical.

The self-employed class has been emphasized but "in" and "out" movements by farm wage workers could also be overestimated. USDA estimates show 3.6 million farm wage workers in 1959 [1, p. 8], but social security taxes were paid on farm wages of only 1.9 million [5, p. 6]. This difference can be largely explained by workers' not meeting minimum requirements. Farm wage work is counted only when (1) the worker's cash pay in a year from one

employer⁷ amounts to \$150 or more, or (2) the employee performs agricultural labor for one employer on 20 or more days during the year.

The important point is that a farm wage worker's income might be reported irregularly because his farm earnings were low and variable. And these are income characteristics of many casual farm workers. Also, earnings could remain the same from year to year but not get reported in some years because the worker had several employers and received less than \$150 from each.

It is possible and seems likely that many of the apparent job movements are due to the peculiar nature of social security data. Further work appears to be needed before policy decisions are based on the authors' conclusions.

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⁷ Farm crew leaders are usually considered to be employers.

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LABOR MOVEMENTS BETWEEN FARM AND NONFARM JOBS: REPLY

Mr. Reinsel, in his comment, has emphasized the problems inherent in the use of social security data for mobility analysis: problems which have been of much concern to us as researchers over the decade during which we have worked with these data. We believe that his view greatly exaggerates the problems, fails to recognize the advantages of these continuous-register data, and leads to unjustified doubts about the conclusions we have drawn from our analyses [3, 4, 6].

Specifically, Reinsel criticizes our use of these data as a basis for mobility policy recommendations on two counts: (a) the comparability of social security data on the farm operator work force with data from other sources on farm operators, and (b) the limits on earnings creditable for social security purposes which might result in an overestimation of gross movements between farm and non-farm jobs. Our awareness of the first of these problems is evinced by the fact that two doctoral theses were completed at Michigan State University to explore the comparability and utility of the data *before any results were published* [1, 9]. The second also was examined at length in a doctoral dissertation before the publication of any results [5]. These studies are cited and partly reproduced in our bulletin [6] and in an earlier publication [10].

The contention that we may have overestimated gross farm labor mobility is belied both by checks which we made on our estimates and by the consistency of these estimates with

census counts of gross migration. Use of a dummy variable technique in multiple regression analysis permitted examination of the off-farm mobility rate of farm operators in the specific income classes about which Reinsel expresses concern, namely, those in the highest and lowest income classes and those using the optional reporting method. None of these census groups exhibited significantly higher off-farm mobility rates. Nor are Reinsel's general misgivings about the effects of persons opting into and out of social security participation on gross mobility estimates warranted, since those who had continuous coverage actually exhibited higher mobility rates [5]. In the case of farm wage workers who were multiple jobholders, very high gross mobility rates were observed and attributed to the unstable job pattern of casual, seasonal, and migratory workers who have little commitment to either farm or nonfarm employment [4, 6]. Nevertheless, Reinsel notes this point in a manner which suggests that we had ignored it.

Our estimates of gross farm labor mobility should surprise no one who has examined census gross migration data.¹ For example, farm-to-nonfarm migration between 1949 and 1950 averages 7.8 percent whereas nonfarm-to-farm migration averages 3.8 percent. Since these rates refer to the entire population and to migration, one would expect the *mobility* rates of persons in the *farm labor force* to be substantially higher, as our estimates indeed indicate. In addition, our re-

¹ See Perkins [5], and also Sjaastad [7].

sults are consistent with those of other mobility surveys [8] and with discussions with farmers [2].

Despite problems in the use of social security data, we believe that the continuous-register nature of these data far outweighs their disadvantages. The world would be a wonderful place indeed if researchers had perfect data. But we do not, in any area; yet we tabulate, correlate, simulate, program, and publish research

results, and policy is made on the basis of this incomplete information. We believe that policy based upon our research will be at least as soundly based as most, and more soundly based than if it depended solely upon the traditional cross-sectional census or survey tabulation.

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POTENTIAL ENTRANTS AND PROJECTIONS IN MARKOV PROCESS ANALYSIS: COMMENT

The article by Stanton and Kettunen [2] clearly points out that the number of firms assumed to be potential entrants to an industry is not a passive variable when the number of firms in an industry is projected through the use of Markov process analysis. It deals with the case where the number of firms which do enter an

industry at each size is known, but the number which could enter but do not is unknown. Therefore, the total number of potential entrants is not known.

Let us refer to the total number of potential entrants as N_t , to the number of firms which desire to enter but which cannot (or do not) as n_o , and to those entering at size levels 1, 2, . . . ,

j as n_1, n_2, \dots, n_j . We then have $N_t = \sum n_i$ ($i = 0, 1, 2, \dots, j$).

In the example cited, n_i where $i = 1, 2, \dots, j$ is known; n_0 and N_t are unknown.

Stanton and Kettunen show the importance of selecting a "proper" N_t , since as N_t is increased the estimate of the number of active firms in some future time period decreases at a decreasing rate. They state: "This effect may explain in part why workers have chosen arbitrarily to use a large number for N [N_t]. Such an assumption meets the requirements of the perfect-competition model but is not as satisfactory when competition is restricted" [2, p. 635].

They conclude that when conditions in the industry under study resemble those of perfect competition, the number of potential entrants (N_t) should be large relative to the number of active firms. On the other hand, they state that when conditions resemble those of monopoly the choice of N_t should be more restrictive. This conclusion, taken with their analysis exploring the effects of various sizes of N_t , leaves us with the contradiction that a more nearly competitive industry will in the future have a smaller number of members than would the same industry had it been at the monopolistic end of the market structure continuum.

We believe that Stanton and Kettunen have applied the theory of market structure to the wrong variable. In the usual conception of equilibrium economics, the number of firms *desiring* to enter an industry is a function of the amount of excess profit enjoyed by firms in the industry and the degree to which this amount is public knowledge. On the other hand, the theory of market structure classifies industries

not on the basis of those desiring to enter but on the basis of the number of firms in the industry, product homogeneity, *freedom of entry*, and independence in decision making [1, pp. 206-207].

In the light of the above reasoning, we submit that, rather than giving implications about the size of N_t , market structure theory should be used to make implications about the size of n_0 . In perfectly competitive industries, no barriers to entry exist. Thus, all firms who desire to enter an industry are able to do so. Therefore, we would hypothesize that n_0 would in this case approach zero, and N_t would equal

$$\sum_{i=1}^j n_i.$$

At the extreme of complete monopoly, all potential entrants would be excluded; therefore n_0 would equal N_t and n_i would equal zero ($i = 1, 2, \dots, j$).

This construction could be made operational by selecting a value for the a_{00} cell (probability of not becoming an active firm) in the Markov transition matrix [2, p. 635] such that it designates the degree of competition in the industry. That is, $a_{00} = 0$ reflects perfect competition and $a_{00} = 1$ reflects perfect monopoly. Thus a_{00} could take on values from 0 to approximately 1, depending on the degree of competition in the industry.¹ Once this cell was established, the

¹When $a_{00} = 1$, the computed value of N_t will be undefined. Only under perfect monopoly will this be the case and in such an industry there is a single firm. Therefore, we need not be concerned with the transition of firms in perfect monopoly through time. For the purpose intended, then, a_{00} approaches one only at the upper limit.

number of potential entrants N_t could be calculated as

$$N_t = \frac{\sum_{i=1}^i n_i}{(1 - a_{00})}.$$

This causes a solution to be generated which gives a larger future number of active firms under competition than for the same data under monopoly. This method uses the theory of market structure as it reflects industry entry in a more basic manner than is the case in the Stanton and Kettunen article.

One further note seems appropriate on this subject. We recognize the basic deficiency of Markov process analysis, as did Stanton and Kettunen [2, p. 633], in that it implies aggregates of economic forces which do not submit to specific theoretical test.

However, we feel that many useful applications of this tool can and will be made as more economic premises can be incorporated into models which use the basic Markov process. An indication of this is given by Telser [3], who assumes that the transition probabilities are functions of certain variables and that the way in which the probabilities change may be determined by changes in these variables. When richer models are constructed and the now skeleton framework is clothed with more specifiable variables, Markov process analysis may enjoy more legitimate economic application.

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POTENTIAL ENTRANTS AND PROJECTIONS IN MARKOV PROCESS ANALYSIS:

REPLY

One of the objectives of our original article was to draw attention to the effect of alternative assumptions about the number of potential entrants on subsequent projections for an industry. This objective appears to have been met. Lee and Berry comment on specific ways of estimating the total number of potential entrants or the probability value for the upper

left-hand corner of the transition probability matrix. We share their concern for careful thought in selecting a value for this variable.

Increasing use of the Markov process approach in studying structural change in an industry is likely. For short-run projections of expected changes in an industry, alternative calculations using different values for

N or a_{00} may be helpful. After all, each of the probability values in the original P matrix are only estimates of the "true values" based on historical observation. Error in estimating any of these probability values will affect subsequent projections. But the key assumptions relate to rates of exit and entry, and both of these rates may be established on *a priori* grounds by the analyst as well as internally by Markov process analysis.

The number of potential entrants will always be determined in a manner which is subjective in some sense. In a historically declining industry, the assumption of large N in a regular Markov model suggests more rapid rates of decline than does the assumption of small N . Conversely, in an expanding industry, such as that studied by Irma G. Adelman ["A Stochastic Analysis of the Size Distribution of Firms," *J. Am. Stat. Assoc.* 53: 893-904, Dec. 1958] and characterized by restrictions to competition, assumption of large N increases the rate of increase both in numbers

of firms entering and in their size. Lee and Berry's comments with respect to the correspondence of probability values of 0 and 1 to perfect competition and monopoly appear less realistic in this case. Where major restrictions to competition exist, changes in numbers should be expected to be slow compared with changes under competitive conditions.

For economists projecting structural changes in an industry, Markov process analysis is a helpful tool. Consideration of one or more absorbing states in the analysis may be most realistic. Hypothesizing rates of entry from outside the system in succeeding periods may be appropriate. Like any tool of analysis, it should be adapted, insofar as possible, to meet the needs of the research problem considered.

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AN ECONOMIC APPRAISAL OF FUTURES TRADING IN LIVESTOCK: COMMENT*

The analysis by Skadberg and Futrell of futures trading in live beef cattle correctly points out many characteristics which make cattle feeding and marketing different from the grain business [3]. However, they

err by analyzing hedging of cattle on feed in terms of guidelines developed in the grain trade. Firms engaged in storing grain modify the commodity to some degree, but their output is quite similar to their input in physical form. Consequently, these firms can hedge grain by using only the commodity market in grains.

Cattle feeders, on the other hand, produce a finished product—fat cattle—which bears little resemblance to the calves and feed that are the prin-

* In writing this article, I have been greatly assisted by the comments of L. V. Manderscheid at Michigan State University, and I have drawn heavily on knowledge gained in Roger W. Gray's course on futures markets at Stanford University. *Michigan Agr. Exp. Sta. J. Art.* 4320.

cial inputs. They must consider the relationship between their purchased inputs, feeders and grain, and their output, fat cattle, in hedging their feeding margin.¹

Conceptually, cattle feeders can implement a quite complete hedging program because futures are traded in corn, soybean meal, feeder calves, and fat cattle. A feeder who follows a very simple, routine hedging plan could proceed as follows: At the time he buys feeder calves, he feels reasonably certain about what his corn and soybean meal will cost (especially if he has grown his own corn and beans) so that the expense and bother of transactions in futures for these items does not seem worthwhile, but he is not sure what fat cattle prices will be when the cattle are sold. When he buys feeder calves, he sells fat cattle futures for the month that corresponds most closely to the anticipated month of sale. The fat cattle futures are bought back when he sells fat cattle. The feeder is assured of the margin which exists between his cash purchases and the sale of the future in October. This result depends on the futures price's being nearly equivalent to the cash price when the futures contract matures, which will tend to occur because of the possibility of delivery on the contract—although the timing and location of deliveries and the variation in cattle will affect it. A feeder who buys corn as needed may wish also to hedge routinely in the corn futures market.

As we include more opportunities in the hedging program for the feeder

¹ These ideas appear to be similar to those developed independently by Paul and Wesson for the soybean crushing industry [1] and later applied to cattle feeding [2].

to use his discretion at points of decision, we move from routine hedging to what is commonly called selective hedging. The differences between the two are questions of degree. Let us now look at how a feeder could use selective hedging to establish his margin. Throughout the year he would watch the margin in the futures markets between months in which he has taken or will take a position; when the margin reaches a value which he believes is the best that he can do, he sets his margins by buying feeder futures and corn futures and selling cattle futures. He may set his margin before he buys feeders, while he feeds feeders, when he markets fat cattle, or after he markets fat cattle. Liquidating transactions in futures would be carried out when he makes cash purchases or sales—selling cattle futures when he buys calves, for example, or buying fat cattle futures when he sells fat cattle. If offsetting transactions were not made simultaneously, but liquidating transactions were performed when the lowest anticipated margin occurred, the transactions would be speculative.

In order for a feeder to hedge to best advantage, he needs an easily understood measure of margins which is simple for him to adapt to his operation. A straightforward method is simply to subtract the variable costs of producing 100 pounds of beef from the market price per hundredweight. An example for a hypothetical feeder is

$$\begin{array}{r} \text{margin/cwt.} = \text{price of fat cattle/cwt.} \\ - \quad 4 \text{ (calf purchase price/cwt.)} \\ \hline 10.50 \\ + \quad 55 \text{ (corn price/bu.)} + 36 \\ \hline 10.50 \end{array}$$

This formula reflects the following assumptions: feeder calves weigh 400

pounds at the time of purchase, the expected weight of the fat cattle at selling time is 1050 pounds, 55 bushels of shelled corn are used per steer, and other variable costs total \$36 per steer. These figures, of course, vary among operations, and each feeder would use a measure appropriate to his own business.

Whatever measures of margins are used, it would be helpful if someone would report them regularly as they apply to "typical" operations. Feeders would need some idea of how much the measures fluctuate and at what values margin setting in futures should be avoided or carried out. Within general guidelines, each feeder would use his own discretion. The extension service, commission firms, and brokerage firms might do their clients a useful service by quoting such measures along with other market information.

This approach de-emphasizes many of the characteristics cited by Skadberg and Futrell as making cattle hedging

impractical. The hedge is not based on ideas with their roots in storage concepts, so the fact that little beef is stored is not important. The cash and futures market transactions are comparable in the kind and quantity of the commodity bought or sold. The spread between two futures (or a cash and a future) market prices for *different commodities* replaces the basis between cash and futures prices in a *single commodity* as the determinant of the success of the hedge; technical production relationships should insure that this spread stays within certain bounds, just as technical storage relations limit the spread in a grain hedge. The degree of market liquidity is an important determinant of how well the spread behaves. Thus, fat cattle futures, like those in the grain market, can play an important pricing role by helping to stabilize the margin in cattle feeding.

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AN ECONOMIC APPRAISAL OF FUTURES TRADING IN LIVESTOCK: REPLY

Mr. Nelson's comments on our article in the December 1966 issue of this journal seem to indicate that he has misinterpreted the main point of our paper. Many of his comments appear to support and reinforce our own ideas. We do not analyze hedging of cattle on feed in terms of guidelines

developed in the grain trade. In fact it was, and still is, our contention that traditional guidelines and logic should not be applied wholesale to the new livestock futures markets. Thus, our second paragraph states, "We believe that there has been a tendency to transfer conventional futures market

logic to these new markets without appropriate adaptation or consideration of the nature of the markets concerned. This paper therefore challenges the applicability of some aspects of traditional futures market form to futures trading in live cattle and hogs."

The main theme of our article is that characteristics of livestock production and pricing place some limitation on the degree of precision with which price protection can be achieved through hedging. We also maintain that certain features of the live cattle futures market are different from more conventional futures markets, and that these differences need to be recognized for their possible impact on hedging technique and results.

Mr. Nelson stresses the potential of selective hedging versus routine hedging. Again, we agree wholeheartedly. We emphasize this on page 1488 in the following paragraph: "This does not mean that the market will not offer attractive hedging opportunities at times. It does suggest that substantial skill is required in determining opportune times for hedging with cattle futures, in evaluating the market position taken, and in completing the transaction most advantageously."

The "straightforward" method that Mr. Nelson suggests for evaluating hedging possibilities has merit. He is correct in saying that this approach de-emphasizes many of the characteristics of the live cattle market cited in our article. It also de-emphasizes his apparent basic point of discussion that hedging of cattle should not be analyzed in terms of guidelines developed in the grain trade, since this method in part assumes some very conventional futures market relationships.

The simplifying assumptions of his hedging method ignore what we feel is an important consideration in evaluating hedging opportunities with live beef futures. This is the relationship between the price and quality of the cattle hedged and the price-quality package represented by the futures contract. Not only is the cash price range relatively wide for choice grade steers, but also the price relationships between weight and quality levels within the choice grade are by no means constant. Hence, his statement that "the cash and futures markets transactions are comparable in kind and quantity" assumes away one of the limitations to precise hedging of live cattle which we feel exists.

We seem to agree on our ideas about the relevance of basis in the live cattle futures market. We point out that basis and basis change related to time periods are not applicable in live cattle futures but that basis due to location and quality is quite relevant. These differences may not impair hedging potential, but they do need to be recognized when market positions and expectations are evaluated.

Mr. Nelson's formula for estimating the margin available from hedging cattle feeding operations can be a useful starting point and a guideline as to whether the futures market offers an alternative that warrants closer consideration at a particular time. But it is by no means in itself a sufficient guide to selective hedging. More detailed study of the particular feeding situation involved would be needed before a hedging decision should be made.

Mr. Nelson states that "fat cattle futures . . . can play an important pricing role by helping to stabilize the margin in cattle feeding." This will

take place only if these guidelines are used widely enough by feeders or hedgers to force adjustments in feeder cattle and/or feed prices which are consistent with live cattle futures prices.

A final comment: Mr. Nelson states that we took the position that the characteristics of the live cattle market cited in our article make cattle hedging impractical. We did not say this at all. We did say that "the futures market in live cattle does not offer significant hedging or pricing potential at this time." We recognize that favorable hedging opportunities have ex-

isted at times during the past two years. But in our judgment, the major points of our article are still relevant and must be considered in evaluating hedging opportunities. The approach to hedging live cattle is different from conventional futures markets; the degree of hedging protection available is limited by certain characteristics of cattle production and pricing; and the economic incentive for speculation and hedging may be limited by these characteristics.

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AN APPLICATION OF STATISTICAL DECISION THEORY TO COMMERCIAL TURKEY PRODUCTION: COMMENT

In their recent article, Eidman, Dean, and Carter [2] made an interesting application of statistical decision theory to the decision problem faced by a turkey producer in an integrated industry. However, they seem to have overlooked the simplicity of their model and used simulation methods where direct analysis would have been more accurate and easier in many respects.

Table 4 of the article [2, p. 862] presents the unconditional probability distribution of net returns under contracts A and B, and also the conditional distribution for an independent producer where returns are statistically dependent on a price forecast. Within the decision framework used, a policy or decision rule is defined by a function $D(P)$ that specifies a choice of contract A, contract B, or independent production for each price forecast P . Eidman *et al.* used simulation to evaluate six such policies by simu-

lating the probability distribution of the sum of net returns over a ten-year period for each policy.

The primary purpose of this note is to show that these policies can be evaluated analytically without simulation, and also it will be pointed out that the policies considered by Eidman *et al.* are unnecessarily restrictive. The discussion uses annual returns but the results are applicable to any finite planning period since the assumption of normality on the annual return functions implies normality for a sum of the annual returns. And as is well known, the parameters for the longer period are related in a very simple way to those for the annual period. If annual returns should show evidence of being skewed, the gamma distribution has this same advantageous property of the normal.

First, let us define each price forecast as a state which has an associated probability, p_i , for the i th state. In

Table 4 of the article, the number of states is eight, one each for columns 4 through 11. These probabilities, p_i , can be computed from regions of the assumed bivariate normal distribution for prices of tom and hen turkeys. For example, the probability associated with column 5 would be

$p_2 = Pr[17 < P_H \leq 19, 15 < P_T \leq 17]$, where P_H and P_T are prices of tom and hen turkeys and column 5 is denoted as the second state.

A strategy or decision rule specifies one of the contractual arrangements (no contract being a choice of contract) for each state i . Let k denote the contractual arrangement in general such that $k = 1, 2$, or 3 implies contracts A, B, or no contract, respectively. Then a decision rule is comprised of a sequence of eight values for k , one for each state. For example, a policy of following contract A regardless of the price forecast would be denoted (1, 1, 1, 1, 1, 1, 1, 1) and the following policy (2, 2, 2, 3, 3, 3, 3, 3) would imply contract B if the price forecast was states 1, 2, or 3 and independent production otherwise.

For any state i and decision k , conditional means and variances can be calculated, as explained by Eidman *et al.* on page 863. Their assumptions imply distinct conditional distributions for each state under independent production, and identical distributions from state to state for either contract A or contract B. Denoting the conditional means and variances under a choice k by μ_{ik} and σ_{ik}^2 , respectively, we have

$$\mu_{i1} = \mu_i, \sigma_{i1}^2 = \sigma_i^2$$

$$\mu_{i2} = \mu_2, \sigma_{i2}^2 = \sigma_2^2 \quad (i = 1, 2, \dots, 8),$$

while μ_{i3} and σ_{i3}^2 change from state to state.

We are now in a position to write a simple expression for the unconditional mean and variance of returns from following any decision rule. The decision rule specifies a value of k for each state i ; therefore, the k subscript on μ and σ is dropped and these parameters are written as functions of a decision variable, d . For any decision rule d , the mean and variance of returns are

$$\mu(d) = \sum_{i=1}^8 p_i \mu_i(d)$$

and

$$\sigma(d)^2 = \sum_{i=1}^8 p_i \sigma_i(d)^2 + \sum_{i=1}^8 p_i [\mu_i(d) - \mu(d)]^2,$$

which follow directly from elementary probability theory.

Since there are three alternatives for each state and eight states, the total number of decision rules is $3^8 = 6,561$, which would be burdensome to evaluate; but most of these could be eliminated by intuitive reasoning. The subset of strategies evaluated could be culled further by deleting any strategy that had a rival strategy with greater mean and smaller variance. The final subset of strategies would provide a set of points in the (μ, σ) plane which could be treated as an approximation to a continuous decision efficiency frontier. The decision theory appropriate for analysis of the problem from this point is presented by Lintner [4], and it was recently applied by S. R. Johnson to farm diversification [3].

Another point that should be mentioned is the very restrictive set of strategies permitted in the Eidman article. A turkey farmer would usually know the contract price before making a decision so that his best decision rule would take cognizance of contract prices under each plan, A and B,

as well as the price forecast. In general, one could visualize a joint density function for the three random events: (1) price under contract A, (2) price under contract B, and (3) the relevant price forecast for the independent producer. These three events would most likely be statistically dependent, but the dependence would be advantageous since it would permit description of the state of the process with fewer discrete states. The simplification from statistical dependence of the state variables is exemplified by the prices of tom and hen turkeys. If they were not so closely correlated, the conditional probability distribution for returns given in Table 4 [2, p. 862] would have to be greatly expanded to permit additional combinations of tom and hen turkey

prices.

Another possibility that should not be overlooked is a combination of strategies comparable to that considered by Burt and Johnson [1] for wheat-fallow decisions in the Great Plains. The success of a combination of strategies is tied closely to the covariance of returns among various strategies. It would take some detailed work on the data to say anything definite about these covariances, but they would be related directly to the correlation between contract prices and forecast prices. A weak correlation would imply considerable leverage for a mixture of strategies compared to a single strategy.

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IMPROVING OUR HABITS OF LITERATURE USE

Last year Dr. Littleton presented to the agricultural economics profession in North America a thoroughly documented report [6] which in many respects should startle us into reflecting on our habits of literature use. Littleton finds that we apparently write a lot more for others than for our colleagues. Consequently we do not seem to read, collectively, what we write. Littleton notes that we prefer to rely on personal exchange rather than

on the perusal of the printed word. This confirms findings made among other professional groups [2, 8].

A vicious circle—disregard of the written medium, disuse of bibliographical services, dereliction of these services, high cost of literature searches, disregard for prior work, further contempt for the written medium—is leading to a crisis in agricultural economics. A true science, what Bressler called "building research upon re-

search" [1, p. 528], must never, even in this MacLuhanesque age, allow itself to neglect the written medium as a means of interpersonal exchange. The purpose of this note is to alert members of this association to the problem and suggest ways in which everybody can help to solve it.

The problem is twofold. First, use of professional agricultural economics literature is somewhat haphazard and uneven within the profession. Communication of new ideas, methods, and results of research is not as efficient as possible. Second, bibliographical services, accession lists like the formidable *Bibliography of Agriculture*, and abstracting journals, whose purpose it is to bring appropriate publications to the attention of appropriate users, for various reasons do not do their designed job. They are not coordinated, and they suffer from the two inefficiencies of *duplication* and *omission*. These inefficiencies discourage workers in our discipline from using even the available bibliographic services.

This state of affairs is regrettable. It deprives agricultural economists of services enjoyed by chemists, biologists, physicians, and other professional groups served by specialized information services. A lack of generally accepted bibliographic services contributes to excessive reliance on word of mouth communication, to factionalism and "schools," to provincialism, to a cynical disregard for written communications ("They only publish for promotion anyway!"), to duplication of research effort, to failure to communicate (as opposed to writing about) important findings, to persistence of confused terminology and contradictory theories that go for a

time unchallenged, and to failure to "build research upon research" except in the more compelling environment of this school or that. It causes inefficiency and wastes resources.

It is easy to lay the blame for the state of affairs on someone else's doorstep. But from personal acquaintance I know of the callous indifference many of us hold towards our own specialized literature. We can hope, perhaps in the near future, to improve substantially literature storage and retrieval services, thanks to the efforts of farsighted members of the AAEA who initiated the Literature Retrieval Committee. The committee is now busy laying the groundwork for a technically sound Information Center for the profession. Its forthcoming proposals deserve our support. In its work, the committee can draw upon the practical experience gathered in hundreds of specialized information centers [6], Littleton's own work [7], and the report of Task Force ABLE [5].

But technical perfection will serve us little if we are not prepared, as responsible individuals, to go a step further. Once we have an efficient literature retrieval system, let us inculcate in ourselves disciplined habits of seeking out, taking note of, and giving credit to, information that is available in the rather extensive body of agricultural economics literature.

A panel convened by the President's Science Advisory Committee, chaired by A. M. Weinberg, issued a report, the recommendations of which we should adopt individually and collectively:

All those concerned with research and development . . . must accept responsibility for the transfer of information in the same degree and spirit that they accept re-

sponsibility for research and development itself. . . . The working scientist must . . . share many of the burdens that have traditionally been carried by the professional documentalist. The technical community generally must devote a larger share than heretofore of its time and resources to the discriminating management of the ever-increasing technical record. Doing less will lead to fragmented and ineffective science. . . . We shall cope with the information explosion, in the long run, only if some scientists . . . are prepared to commit themselves deeply to the job of sifting, reviewing, and synthesizing information. . . . Such scientists must create new science, not just shuffle documents. . . . We urge the technical community to accord such individuals the esteem that matches the importance of their jobs [9, pp. 1-2].

In view of our own experience and the experiences of other professions, as expressed in the Weinberg Report, I would like to suggest the following five points as the basis for consideration and action by members of the AAEA.

1. Let us examine our own personal habits of communication—writing, citing, and reading—and, if found wanting, improve these habits systematically. Let us set an example to help inculcate these habits in our students. Probably we must systematically teach better practices of communication [4].

2. The technical problems to be overcome require thought and deliberation. The literature retrieval committees will invest a great deal more time, money, and effort in specific proposals for improving the present system of bibliographic services. The committees are anxious to cooperate with members wishing to make contributions by communicating suggestions, ideas, and experiences. This is in many ways a new departure for the associations. Any early contribution

will carry weight.

3. The professional associations may either themselves initiate, or demand from their respective governments, decisive coordination and a substantial improvement of the existing specialized bibliographic services. The experience of thousands of members and Dr. Littleton's findings cast doubts on the prevailing practice which treats agricultural economics literature as a mere appendix of a huge "agricultural-biological" information system. We cannot afford to acquiesce in a system that pays mere lip service to the users' demands and sacrifices our special needs to processing efficiency and convenience for the manager of the system.

4. The trend of the times has been very strongly towards specialized information centers, for good reasons. New institutions often have been necessary to cope with new problems. An Agricultural Economics Information Center would be a modestly progressive and by no means unprecedented organization. It would provide some badly needed services immediately. In the long run it would provide a place where the users, the custodians, and the processors of bibliographical information could develop—and keep up to date—an efficient information acquisition, retrieval, and diffusion system.

5. We must learn to accept the tasks of sorting, reviewing, and synthesizing information as equal in importance to the tasks of research, classroom teaching, and extension work. This implies adequate moral and financial support for organizations and individuals who pursue these new tasks essential for staying on top of the "information explosion." It also implies that individuals engaged in sifting, reviewing, and synthesizing in-

formation must be accorded the same professional esteem that we now accord those engaged in the traditional professional tasks.

The profession of agricultural economics in the United States has given agricultural economists in the rest of the world magnificent leadership. Through sensitivity to needs, foresight, and dedication it has contrib-

uted immeasurably to the advance of the nation and has prospered itself. It is my fond hope that North America may be able to retain its position of leadership in the area of agricultural economics literature control, just as it has achieved a position of leadership in agricultural economics proper.

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WHITHER SUPPLY ELASTICITY?

Is quantity becoming more or less responsive to price in the world of farm products? The recent report of the Food and Fiber Commission endorses the orthodox position that both individual firm and aggregate supply elasticities have been increasing.¹ The

intent of this note is to point out that the underlying relationships are complex and to suggest that the elasticity

that of individual commodities. There is reason to believe, however, that even aggregate output response to price changes is greater today than in the past, due principally to the increased importance of inputs purchased from outside the farm" [1, pp. 52-53]. This statement is believed to represent a widely held opinion. The purpose of quoting it is not to reflect in any way on the conclusions of the Commission report, but merely to illustrate a succinct presentation of a particular position.

¹"As American farms become more specialized and more dependent on inputs purchased off the farm, farmers become more responsive to commodity price changes. . . . Without doubt, response of aggregate output in agriculture to change in price is more sluggish than

question may need further empiric examination.

Conventional theory says that supply elasticity becomes higher as the length of run is extended—more inputs become variable. Evidence in support of the argument for higher elasticity (for a given length of run) could be based on some combination of interrelated push and pull components: As more nonpurchased factors, especially family labor, have developed an off-farm opportunity cost (at least in the farmer's eyes) and as more of the total inputs are purchased, the firm becomes more cognizant of costs. Reducing the number of residual income claimants makes response to price change a more urgent condition for firm survival. A larger percentage of purchased variable inputs may also allow more adjustment in input in response to a product price change.

This widely heard argument ignores an important second aspect of opportunity cost arising from the trend to specialization—the concurrent decline in the number of multiple enterprise firms. Except for very long-run decisions, no longer do the firms plan on the basis of opportunity costs of durable resources in alternate production of, say, hogs instead of cattle.² In its place they face a lower opportunity cost in salvage value of a technologic package. Thus, the range of product-product substitution is reduced.

Availability of both additional variables and competitive products would tend to increase elasticity. Although

the rise of specialization and relative increase in purchased inputs makes more inputs variable, it *removes* competitive products from the firm production function for any given length of run. Thus, the two forces have opposite effects on elasticity. A third force must be considered in assessing aggregate elasticity—freedom and ease of entry and exit of firms. It appears to me that the gross and net effects of these three forces are empiric questions requiring answers before we draw conclusions about recent changes in elasticity of supply.

A second question is whether estimates of elasticity need to be qualified as applicable only to some narrow range of direction and duration of price change. The increased product specialization of individual firms has been accompanied by the adoption of specialized durable equipment which, once purchased, becomes a "fixed asset" in the Glenn Johnson sense of having use value between widely separated acquisition and salvage prices [3, pp. 180-217].³ But fixing the asset as part of the firm does not remove the annual capital cost from the cash category if, as is frequently the case, the purchase was made with borrowed money. It is in every sense a cash cost, yet it is not variable once the decision has been made to purchase.

This has two consequences: (1) Not all the increase in cash costs relative to noncash can be used in the previous argument for increased elas-

²The reason may be not so much inflexibility in the technologic packages of specialization as inflexibility in switching the higher levels of management skills required.

³This happens because the aggregate market effect of many such purchases is to reduce market price of product, and hence marginal productivity of the durable, below levels necessary to recover the acquisition cost to the individual firm [5] but above its salvage value.

ticity of supply. Some of the increase becomes in effect fixed and does not affect elasticity. (2) Once the decision to invest has been made, the function may be largely irreversible. Thus, specialization and the concomitant increase in use of durables may make less relevant the conventional concept of the continuous production function, from which a smooth supply curve is obtained.

Kottke has shown that in the case where a set of durable inputs must be considered along with variable inputs, the result for the individual firm is a step supply function [4]. Some steps represent the acquisition of durables and are irreversible. This is characteristic of technologically induced increased specialization. Thus, the question of elasticity in a dynamic setting for policy must raise a question of starting position.

I have argued elsewhere that the step function gives rise to three "response ranges" for the firm, in terms of investment profitability, and defined by the level of product price [2]. In the *expansion range* the product can be produced profitably, and additional investments in durables as well as increased annual inputs are justified. This is obviously a highly "elastic" situation. At a lower price, we have a *stand-pat range*. New investments are not justified, but present durables can be used to capacity. Elasticity is essentially limited by potential variation in nondurable inputs. At lower prices, other types of farming become more profitable, and we have the *cut production range*. Here, annual inputs are cut back and durables may be left unused. Eventually production ceases. Note that once a firm in the expansion range makes the durable investment, it moves into a stand-pat range at a new, higher level

of production. It does not retrace its steps.

If we hypothesize that groups of producers have similar but not exactly coincident ranges, the aggregate curve still exhibits the step pattern but the break between ranges forms a jagged pattern rather than a clear break.⁴ Then aggregate elasticity depends on the starting point within each range and on the amount of price change to be considered in computing the elasticity.⁵ In fact, each time any firm invests in durables, we have new aggregate and firm curves, with separate upward and downward segments. In a farming economy characterized by a mixture of specialized and nonspecialized firms, as well as some in the process of transition, we might expect the "prices" defining the breaks in range to differ. The aggregate curve might thus be approximated by a smooth curve. But much vital information is hidden, especially when farming is in a major structural transition. In analysis for policy purposes, it may be extremely useful to group the firms by response ranges to make analyses of the likely impacts upon different producer groups and of the aggregate impact.

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⁴ Larger jumps will occur at points on the aggregate curve where firms are entering or exiting.

⁵ There is some difficulty in thinking of an elasticity at all with a stepped function. Kottke notes, "It is difficult to generalize such responsiveness into a single elasticity measure" [4, p. 115]. However, it may serve in a general way to summarize the net market consequences of a price change when the many individual step functions have different enough ranges to be roughly approximated by a smoothed aggregate curve.

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NOTE ON THE ESTIMATION OF COBB-DOUGLAS ELASTICITIES

Because the Cobb-Douglas production function is so widely used, it is desirable that empirical estimation of its parameters should be as accurate as possible.

Of the number of estimation methods that have been used in the past, there are two of particular relevance to this communication. First there is the original work by P. H. Douglas and associates¹ on fitting production functions using the least-squares method, and second there is the suggestion by Klein [4, pp. 191-194] of estimating production elasticities from equations resulting from unrestricted profit maximization.

The purpose of this communication is to suggest combining these two methods² along the lines indicated by Theil [5, pp. 401-414] so that the required estimates are obtained from the production function and from the profit maximization equations jointly. Combining information from these two sources should provide better estimates than

can be obtained from either source alone. Since profit maximization is assumed, the results cannot be used to appraise the efficiency of resource allocation, but they can be used for other purposes, such as prediction.

Consider now the function explaining output, Q , in terms of labor input, L , and capital services input, K ,³

$$(1) \quad Q = AL^{\alpha}K^{\beta}$$

where A , α , and β are constants. Given also the price of output, p , the wage rate, w , and the unit cost of capital services, r , then, with competitive markets, we can write the first-order conditions for profit maximization as

$$(2) \quad \frac{wL}{pQ} = \alpha$$

and

$$(3) \quad \frac{rK}{pQ} = \beta.$$

¹ For a summary of Douglas' work in this field see his article [1, pp. 1-41].

² Although a slight modification of Klein's procedure is needed, as noted below.

³ We use only two inputs to simplify the exposition, although the argument can be extended to include any number of inputs.

Both α and β occur in more than one equation and we wish to make use of this fact in estimating these coefficients from sample data.

Putting for notational convenience $Y_1 = \log Q$, $X_1 = \log L$, $X_2 = \log K$, $y_2 = wL/pQ$, and $y_3 = rK/pQ$, and taking logs of both sides of equation (1), we find that the three equations become

$$\begin{array}{rcl} Y_1 & = & \log A + \alpha X_1 + \beta X_2 + e_1, \\ y_2 & = & \alpha + e_2, \end{array}$$

and

$$y_3 = \beta + e_3,$$

where the e_i are random disturbances introduced to explain deviations from exact fit. It should be noted that e_2 and e_3 are additive disturbances here, in contrast to the multiplicative disturbances used in this type of equation by Klein and others. The e_i are assumed to have zero means and constant variances, denoted by σ_{11} , σ_{22} , and σ_{33} ; in addition, they are assumed to have zero covariances, although this last assumption is for illustrative convenience only and can easily be dropped.

Given a time-series sample of T observations on each variable, we shall use the generalized least-squares estimation method⁴ to obtain the required estimates by minimizing the weighted sum of squares

$$\alpha \left(\sigma^{11} \sum x_{1t}^2 + \sigma^{22} T \right) + \beta \left(\sigma^{11} \sum x_{1t} x_{2t} \right) = \sigma^{11} \sum y_{1t} x_{1t} + \sigma^{22} \sum y_{2t}$$

and

$$\alpha \left(\sigma^{11} \sum x_{1t} x_{2t} \right) + \beta \left(\sigma^{11} \sum x_{2t}^2 + \sigma^{33} T \right) = \sigma^{11} \sum y_{1t} x_{2t} + \sigma^{33} \sum y_{3t},$$

⁴ The generalized least-squares estimation procedure is expounded, among others, by Goldberger [2, pp. 231-233], who shows its optimal properties.

$$S = \sum_{t=1}^T (\sigma^{11} e_{1t}^2 + \sigma^{22} e_{2t}^2 + \sigma^{33} e_{3t}^2)$$

with respect to $\log A$, α , and β . The σ^{ii} are the reciprocals of the variances σ_{ii} .

Substituting for the e_{it} in S and minimizing with respect to $\log A$ provides an estimate

$$\log A = \bar{Y}_1 - \alpha \bar{X}_1 - \beta \bar{X}_2$$

which can be readily verified (barred variables denote sample means). Now, substituting this estimate back into S gives a new weighted sum of squares S' , where

$$\begin{aligned} S' &= \sum_{t=1}^T (\sigma^{11} [y_{1t} - \alpha x_{1t} - \beta x_{2t}]^2 \\ &\quad + \sigma^{22} [y_{2t} - \alpha]^2 + \sigma^{33} [y_{3t} - \beta]^2), \end{aligned}$$

and we have set $y_{1t} = Y_{1t} - \bar{Y}_1$, $x_{1t} = X_{1t} - \bar{X}_1$, and $x_{2t} = X_{2t} - \bar{X}_2$. $\log A$ has thus been eliminated and, since it is the parameter of least interest, will be ignored from here on, though we note that it can be calculated from the estimated α and β and the sample means when required.

We can now minimize S' with respect to α and β to obtain the estimating equations

which can be readily solved for the estimates of α and β .

It can also be seen from Goldberger

[2, p. 233] that the covariance matrix of the estimates is given by the inverse of the matrix

$$\begin{bmatrix} \sigma^{11} \sum z_{1t}^2 + \sigma^{22}T & \sigma^{11} \sum z_{1t}x_{2t} \\ \sigma^{11} \sum z_{1t}x_{2t} & \sigma^{11} \sum x_{2t}^2 + \sigma^{33}T \end{bmatrix}.$$

It follows that the standard errors of α and β are the square roots of the diagonal elements of the inverse matrix. By some calculation or by numerical example we can determine that the diagonal elements of this inverse matrix are not larger than those in the corresponding matrix with $\sigma^{22} = \sigma^{33} = 0$ (the Douglas case) and not larger than those in the matrix when $\sigma^{11} = 0$ (the modified Klein case). That is, if we set $\sigma^{22} = \sigma^{33} = 0$ throughout, our whole procedure would be the same as that of Douglas (classical least squares), whereas if we set $\sigma^{11} = 0$ throughout, we would be using the modified Klein procedure.

Thus, combining the two procedures appears to give smaller standard errors than are given by either procedure on its own, and so on this ground the combination should give better estimates.

The error variances and hence their reciprocals σ^{ii} will generally not be known in advance, but they can be readily estimated from the sample data. We can estimate σ_{22} and σ_{33} from residual sums of squares after applying least squares to the profit maximization equations; this procedure also provides esti-

mates of α and β which can be then substituted into the production function,

a procedure from which σ_{11} is indirectly obtained.⁵

The approach of this communication can evidently be extended to include more variables than "capital" and "labor," which were used here merely as illustrations. We may wish to include materials input, for example, or a time trend to pay some due to technological progress. In the case of materials, this approach would bring in an additional profit maximization equation, whereas for the time trend it will not. However, the more accurate estimation of the input elasticities by using the additional information contained in the profit maximization equations should also allow more accurate estimation of a technological progress coefficient, if one is included.

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⁵ Hoch [3, pp. 566-578] observes that least squares applied directly to the production function provide a biased and nonconsistent estimate of σ_{11} . However, the variance estimates need not be very accurate for the combined estimation method to retain superiority over the individual methods.

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COST-ESCALATING IMITATION IN MARKET SERVICES

Conventional wisdom has it that the bundle of market services provided consumers truly reflects the configuration of consumer preferences, else they would not be there. This comfortable idea, deflective against both social concern and economic analysis, persists in the face of the bizarre nature of some of the services, such as giving a lottery ticket along with retail foods. The housewives' protests of late 1966 were unsettling but they did not last long enough to become a challenge to orthodoxy.

There is something unconvincing about that defense in the face of observed increases in tacked-on services. Could there be a patterned performance that results from a particular combination of cost structure and competitive environment?

The hypothesis offered here is that such a behavioral phenomenon does exist.

The sequence is clear enough. An innovating firm adds a service, bonus, or outright bait. The immediate results are heartening, and the new service proves self-financing. Thereupon imitation sets in, as other firms follow suit in order to protect their own volume of business. For the later followers the action is not self-financing, but solely defensive. Furthermore, as new firms duplicate the service, the initial advantage to the innovator vanishes. In the process an industry-wide increase in costs is built in.

The phrase "cost-escalating imitation" is suggested in the title. Another coinage could be "the costly game of denial of differentiation." The innovator adds the service as a means to dif-

ferentiate his operation, but others follow suit in order to deny him lasting success. Beem and Oxenfeldt, in describing their similar "diversity theory," use the dual term, "imitation or retaliation" [1, p. 74].

The most convenient illustrations are from supermarket retailing, though the phenomenon is not confined to retailing. Trading stamps may come first to mind. Attempts to make brand of stamps a differentiator have not been very successful. The innovators reaped windfalls but now the price of groceries is simply increased by 2 percent.

Store hours may be a better illustration. If only one supermarket, or one drug store, or one gasoline service station stays open after hours, for it the practice may be profitable. If its sales during the extra hours come at the expense of regular-hours sales by other firms, the latter will be under considerable pressure to defend themselves by doing the same thing.

Sometimes a live-and-let-live solution emerges, particularly where there is some other element of partial differentiation. A gasoline service station at the intersection of main highways may announce 24-hour service without inducing parallel action by other stations. A grocery in a factory district with swing shifts may alone keep doors open until midnight.

But under other conditions the drive to imitation prevails. The long hours supermarkets are open in some cities probably are traceable solely to the phenomenon hypothesized here. No store individually gains by being open certain hours of limited traffic,

and all would be better off if all would cut back; but no one alone dares close.

The near nonreversibility of the practice, thus hinted at, is a somewhat puzzling feature. Manifestly, the whole matter rests on the absence of any separate and full-cost pricing for the particular item of service. If shoppers were individually and optionally asked to pay 2 percent extra for trading stamps, many would react in almost the same way as they would if they were allowed free choice in paying sales tax. And if the service were withdrawn, they would appear to receive less for the same money. Withdrawal can hardly be popular. Withdrawal of a service is not a true inverse of adding it. The phenomenon is not symmetrical.

The principle described here depends on the pre-existence of certain conditions. There must be short-run excess capacity. Competition obviously must be imperfect—probably a blend of monopolistic competition and perfect oligopoly. There must be more kinds of service differentiation than the number of firms or stores available to each customer; otherwise, the customers would match up with stores and settle down into stable liaisons. The diversified structure of so much of the food marketing system makes that resolution unlikely [2, p. 3]. In a similar vein, the whole idea applies best if the consuming public does not have intense preferences for the various services, but is instead only mildly responsive. That this condition may exist is suggested by the apparent need for discount houses to differentiate sharply in order to survive.

One thing more needs to be said. It

relates to the principle of circular interdependence. If all firms recognized the eventual outcome of the initial differentiation, no one would make the first move. Apparently, some either lack foresight or will fight for short-term gains. On the other hand, it is common practice for merchants to work out understandings, tacitly or otherwise. Drug stores in a city not only close at the same time daily but acquiesce in a single store's remaining open on Sunday. Alternatively they rotate the Sunday duty.¹

As with so many behavioral aspects of imperfect competition, a precise formulation comes hard; again paralleling Beem and Oxenfeldt, it can be said to lack a "rigorous mathematical apparatus" [1, p. 69]. But the principle of cost-escalating services seems persuasive enough to challenge an easy assertion that persistence of added services is a *a priori* proof of their esteem in minds of consumers. A warning, though, against leaping to sweeping public welfare conclusions, which are different when abstracting from imperfect and from perfect competition: peripheral services of nominal worth may be the price of keeping monopolistic competition from drifting into outright oligopoly, just as duplication of plant is the cost of perfect competition. If so, the public interest looks askance at only the more extreme devices that are dreamed up. Moreover, in another en-

¹Beem and Oxenfeldt, in their thought-provoking article, report this as a common practice. The "cooperation" (!) may be only a "tacit recognition of common interest" [1, p. 74]. The principal difference between the Beem-Oxenfeldt analysis and that presented here relates not to the nature of practices but to the performance that results.

gaging contradiction, dealers' conspiracies to rule out certain tangential services can be not only unobjectionable

but positively in the public interest.

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FIRM GROWTH MODELS OFTEN NEGLECT IMPORTANT CASH WITHDRAWALS

In the past few years, greatly increased attention has been given to models of farm firm growth [1, 2, 3, 4, 5]. However, many of these studies ignore social security contributions and federal income taxes, both of which are rather obvious and could be fairly easily included. Also, farm family consumption, a third cash withdrawal, typically is based on assumed relationships rather than relationships with empirical basis. To the extent that these cash withdrawals are underestimated, results of growth studies will be biased upward. Further, such errors tend to be compounded in each production period.

This communication has two purposes. One is simply to point out the importance of including these items in growth studies. The second is to offer a consumption function which has at least some empirical basis.

Social Security and Income Taxes

Both social security and income taxes are rather obvious and deserve little elaboration except that they have been so often ignored. In 1968, a self-employed farm operator will pay into social security 6.4 percent of net income on the first \$7,800 of income—a withdrawal of as much as \$500

from the amount available for reinvestment. (In 15 years, \$500 per year amounts to \$11,638 at 6 percent internal rate of return.) The cost is scheduled to increase in the future.

Similarly, the operator interested in business growth cannot ignore effects of federal income taxes. Although the relationship of tax management to firm growth is itself an important research need, that is not my point here. Taxes need to be included in the growth model because they constitute a significant cash withdrawal with prior claim over reinvestment.

Consumption

Current consumption is a more difficult problem. There is little research on consumption functions easily usable for farm growth models. One source of national data is the 1960-61 survey of consumer expenditures for the rural farm population [7]. However, these data are seven years out of date. Also, one can question combining regional data when inspection suggests that there are regional differences in the consumption function along the lines suggested by Raup [6, p. 174]. Still, these are probably the best data available, and their use in deriving a consumption function

may be preferable to functions with little empirical basis.

These published data were used to fit a regression model of the type $C = AI^{b_1}S^{b_2}$, where C is current consumption as defined in the source but also includes personal insurance (except social security), gifts, and contributions; I is after-tax income, and S is family size. The functional form was based on logic and graphic analysis of the data. The data came from the 1960-61 USDA survey [7, Tables 29D-H] and include cross classifications based on income and family size. The income categories below \$2,000 were omitted from this analysis because the data show that below this income the family maintains current consumption in excess of \$2,000 by either selling assets or increasing liabilities. Including either category would have forced an improper slope into the regression. A weighted regression based on observations in each category was fitted to the 40 arithmetic means. The range in mean current consumption was \$2,535 to \$10,911; in income after taxes, \$2,502 to \$23,690; and in family size, 2.0 to 7.7.

The estimated relationship was as follows:

$$\text{Current consumption} = 22.96I^{0.590}S^{0.163}$$

The R^2 was 0.947, but this and other statistics of the regression are not very meaningful since the regression was based on means rather than on individual observations. Hence, much of the individual variation was removed prior to the regression. The R^2 suggests only that the estimated relationship fits the means rather well.

Results indicate a current consumption elasticity of after-tax income of

0.590. The coefficient for family size indicates that a four-person family spends about 12 percent more on current consumption than a family of two, and a family of six, about 6.8 percent more than a four-person family.

Example of Combined Effects

Table 1 suggests the relationship of social security, federal income taxes, and current consumption to net income and its reinvestment potential. Of some importance here is the fact that data in the table indicate somewhat less income available for reinvestment than generally assumed in growth models.

By 1968 these data were seven years old. Relationships could have changed in the interim. No doubt relationships have been affected by increases in consumer prices. However, to adjust the model for price increases, assume that the estimated function related *real* current consumption to *real* income; that is, $(C/P) = 22.96 (I/P)^{0.590} S^{0.163}$, where P is the ratio of current to 1961 price. The current dollar relationship would then be $C = 22.96P^{0.410} I^{0.590} S^{0.163}$. With this adjustment, a given percentage price increase and the same percentage rise in income after taxes result in the same real level of consumption. With a 15-percent rise in consumer prices since the collection of the data, current consumption would be increased by 5.9 percent. This adjustment would increase the breakeven income from about \$4,000 to about \$4,700 for a four-person farm family.

In summary, models for analyzing firm growth will be much more useful and accurate if they incorporate cash withdrawals for social security, fed-

Table 1. Reportable net income, social security costs, federal income taxes, and estimated current consumption for selected farm family sizes

Reportable net income ^a	Number in family	Social security self-employment cost ^b	Federal income taxes ^c	After-tax income	Estimated current consumption ^d	Amount available for reinvestment
\$ 3,000	2	\$192	\$ 200	\$ 2,608	\$2,670	\$ 62
	4	192	0	2,808	3,121	313
	6	192	0	2,808	3,334	526
6,000	2	384	658	4,958	3,901	1,057
	4	384	450	5,166	4,473	693
	6	384	230	5,386	4,897	489
9,000	2	499	1,171	7,330	4,913	2,417
	4	499	943	7,558	5,600	1,958
	6	499	715	7,786	6,087	1,699
12,000	2	499	1,776	9,725	5,806	3,919
	4	499	1,512	9,989	6,602	3,387
	6	499	1,266	10,235	7,154	3,081
15,000	2	499	2,460	12,041	6,586	5,455
	4	499	2,172	12,329	7,475	4,854
	6	499	1,908	12,593	8,085	4,508
18,000	2	499	3,210	14,291	7,287	7,004
	4	499	2,910	14,591	8,257	6,334
	6	499	2,610	14,891	8,926	5,965
21,000	2	499	4,044	16,457	7,920	8,537
	4	499	3,708	16,793	8,971	7,822
	6	499	3,372	17,129	9,695	7,434

^a Net income reportable on Form 1040.

^b 1968 schedule of 6.4 percent on first \$7,800 of income.

^c Using standard deductions, joint return, and 1967 tax rates.

^d Based on 1961 data not adjusted for price changes.

eral income taxes, and farm family consumption. Perhaps the current consumption function presented here can be used for this purpose. Meanwhile, research is needed to develop

more appropriate functions.

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Reviews are listed alphabetically by authors.

Reviews

Ball, Joyce, ed., and Roberta Gardella, compiler, *Foreign Statistical Documents*, Stanford University, The Hoover Institution on War, Revolution, and Peace, 1967, vii + 173 pp. (\$5.00)

This valuable reference and research bibliography on general statistics, international trade statistics, and agricultural statistics includes a list of holdings of the Stanford University libraries and focuses on foreign statistical documents, mainly the publications using a Western European language.

The publication is the outgrowth of a postwar project begun in 1946 for acquiring foreign statistical documents, many of which had not been published during World War II. The renewal of acquisitions represented a cooperative effort by the Library Committee of the Food Research Institute, the Stanford Library, and the Hoover Library on War, Revolution, and Peace. The project was made more comprehensive in 1958 by supplementing the annual reports with monthly or quarterly publications and modified again in 1964 by updating and acquiring statistical documents to add to those listed by the survey.

The "guide" to the use of the bibliography by country is helpful but could have been made more useful if the editor had selected alphabetical identifications that could be followed more readily. For example, the reviewer suggests that "GSA" would be a better identification than the listed "SA" for *General Statistics, annuals*; "GSB" might be used instead of "SB" for *General Statistics, bulletins*, and "TSA" rather than "CA" for *Trade Statistics, annuals*. Similarly, with regard to the symbols, one showing that the serial is still being published other than the negative sign used might be more meaningful.

These criticisms detract little, however, from the over-riding fact that *Foreign Statistical Documents* is a convenient research tool for aid, trade, and economic development studies. In view of the major U.S. role in such activity, this publication represents a significant contribution in listing highly useful but difficult-to-find documents for facilitating improved program and policy decisions.

ROBERT L. TONTZ

Economic Research Service, USDA

Balogh, Thomas, *The Economics of Poverty*, New York, The Macmillan Company, 1966, xvii + 381 pp. (\$7.95)

To judge by titles, the word *poverty* in England means development of less-developed countries. If Keynes had lived to the time of faster air travel, his collected essays on this subject might have been similar in scope to those of Thomas Balogh, who became interested when he wrote a report on Malta for the Labour Government in 1955. After that, he "rarely spent university vacations and sabbatical leaves at home," [p. xii] and a criticism is that the essays leave just this impression of being written on the run. Although the results do not compare in stature with what Keynes would have done, Balogh ably practices in the verbal economic tradition. Another reason his views are of interest is that he emphasizes agriculture.

Fragmented labor markets, credit systems geared to channeling savings out of less-developed countries, rural underemployment, and land tenure impediments are prominent in the opening chapters attempting to give an overall framework. After this, there are two chapters presenting Balogh's version of how to transform primitive agriculture, then two chapters on education stressing rural needs, followed by four chapters on international topics featuring agricultural primary products. The last half of the book applies the views with fair consistency to countries in the Mediterranean region, Africa, Jamaica, and Asia, closing with two essays on India.

The policy views are not as different as would be expected in view of the dissenting language, the concern with imperialism, and the warning at the beginning that Balogh was early convinced that "the simplistic rules based on perfect competition and the implied unimportance if not complete irrelevance of size, social framework and psychological attitudes made nonsense of the problems of all but a handful of countries" [p. xii]. Land reform is favored but not seen as a panacea, in some cases raising threats to productivity. Possibilities are discussed for mobilizing rural labor to build roads and undertake other investment projects, through requiring citizens to give days of service and other schemes. A mildly progressive land tax is favored, as are rural cooperatives. Balogh agrees with others in urging measures to develop new crop varieties and increase supplies of fertilizers and other nontraditional inputs. Education thrusts advocated are combatting illiteracy and fostering technical education. It is pointed out that not all primary producers are low-income countries, and several failings of compensatory financing are noted. Therefore, instead of seeing much hope of achieving development through trade policies, Balogh prefers aid and soft loans tied to internal reforms and direct controls.

A major strength of this book is that it views agriculture in a total development process, giving advice flowing from sector-by-sector review of country problems using the framework of economics. Another strength is that more recognition is given to political and administrative problems than is given by most competent economists who have been concerned with giving development advice. Among weaknesses, superficiality should be mentioned. Perhaps Balogh should have travelled by boat and taken time for more analysis. Little new research depth is obtained in any of the subject matter areas. A book of this

length is not needed to spell out Balogh's positions. There is a problem of balance. One can agree that comprehensive regional (multi-country) planning is desirable, but the benefits from it seem overstated if one thinks of all of the other obstacles to growth. Less energy should be devoted to sharp-tongued criticism of others and more to the specifics of the policies advocated. Another weakness is confident assertion in favor of his own views when a hypothesis-testing attitude would be appropriate. Balogh states that he favors empirical research, but he has unkind comments on attempts of others and does not seriously consider the quantitative implications of his recommendations.

This book is useful in stimulating rethinking, because it deals with key topics and because the ways in which it fails suggest how research might contribute more fully to development. Now that the range of controversy about policy directions has been narrowed, there could be more serious testing of those issues, for example, trade versus aid, where there is still disagreement. Even more to the point would be analysis and estimation to help decide which new varieties to develop, where to build fertilizer plants, what the realistic expectations are for increasing production, and how to make careful inferences from previous experience to help guide future development planning and education policies.

GEORGE S. TOLLEY

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Christy, Francis T. Jr., and Anthony Scott, *The Common Wealth in Ocean Fisheries*, Baltimore, The Johns Hopkins Press for Resources for the Future, Inc., 1965, xiii + 281 pp. (\$6.00)

The sea is sometimes described as the last frontier on the earth's surface. Although 70 percent of the earth's surface is covered by the oceans, they provide only a small fraction of man's food supply. Our scientific knowledge of marine resources, although beginning to accumulate, is much less than for land-based resources. It remains a challenge to man to determine the sea's potential food yield and the most effective arrangements for extracting food from the sea.

This book is intended to introduce economists and other social scientists to knowledge about the marine fisheries of the world. The emphasis is on problems associated with economically rational development of the fisheries. A primary purpose of the book is to attract increased attention by social scientists to the problem areas discussed.

The book begins with a brief theoretical discussion of the use of common property resources. Technical and institutional factors related to supply of and demand for fish are then examined in detail. The description in this section includes the fertility of different ocean regions, distribution of fish populations, the process of catching, processing, and distributing fish, and patterns of consumption. Next, the discussion turns to the legal environment, including a review of the international law of the sea and a description of fishery treaties and commissions. Finally, alternative arrangements to manage international fisheries

are investigated. An afterword contains suggestions for further research by social scientists.

The central theme of the book is that ocean fisheries will not be developed rationally as long as they remain common property resources. Outside the narrow bands of territorial waters adjacent to land, the remaining large portion of the oceans is international water, and the fish within it are common property of all the nations of the world. Competition among individual users of the fishery resource results inevitably in excessive commitment of labor and capital, congestion, conflict, and depletion of the fishery. When problems become severe, the countries active in a fishery may develop bilateral or multilateral agreements that impose some type of control on the fishery. The controls typically limit such things as the length of the fishing season or the size of fish that are removed, but they do not prevent the excessive application of fishing effort. Hence, the agreements may prevent depletion, but they do not prevent economic inefficiency.

Alternative arrangements to achieve international economic efficiency are examined. Extension of coastal states' sovereignty or use of national quotas are concluded to be undesirable solutions. The authors favor management of the fisheries by an international authority which buys labor and capital in the cheapest markets and sells the products in the dearest markets, distributing profits among world nations on some equitable basis. Others may feel that this solution is idealistic and that it would be impossible to attain such a high degree of international cooperation. However, any type of improvement over the present regime requires international consent. The need for revision is seen to be urgent. A world-wide extension of fishing effort is putting increasing pressure on fishery resources and causing more frequent and severe problems.

Readers who expect to discover that the sea offers panacean solutions to world food problems will be disappointed. The maximum sustainable output of presently desired species of fish possible through the use of present fishing technologies may be no more than twice the present output. Development of demand for fish species not presently used or further improvement of fishing techniques would make greater output increases possible. The book mentions that "the recent rate of growth of technological innovation is impressive" [p. 102]. Nevertheless, fishing remains basically a hunting process, with men in boats searching for an invisible and uncontrolled prey and catching it with hooks or nets. The science of aquiculture (farming the sea), potentially the most impressive technological development, is still in a stage of infancy.

The book achieves effectively its stated purpose. It is wide in scope, yet it is written concisely. It is noteworthy that the authors were able to combine information from several different fields of knowledge in a smoothly readable manner.

Because the book has considerable strength in breadth, it is understandable that it does not have equal strength in depth. To economists, the theory chapter is likely to be disappointingly brief and simplified, and the simple static economic models presented in the chapter may leave them doubtful about the generality of the conclusions. It should be noted, however, that the general conclu-

sion that economic inefficiency results inevitably from competitive exploitation of a common property fishery resource is verified in other, more extensive theoretical discussions. Experts in fishery biology, fishery technology, or law would likely note a similar lack of depth in other parts of the book. However, the coverage is probably adequate for social scientists getting a first exposure to these areas.

I do not know of any other recent and comparable book. It is recommended to social scientists who want a stimulating introduction to knowledge about marine fisheries.

DAVID A. STOREY
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Dietze, Constantin von, *Grundzüge der Agrarpolitik*, Hamburg, Verlag Paul Parey, 1967, 291 pp. (DM 36.00; \$9.00)

Developments of Common Market agriculture and agricultural policy in the European Economic Community are of significant interest to the United States. Newly published books on agricultural policy in any of the Common Market countries can, therefore, have a potentially high value to the American agricultural policy researcher, teacher, and practitioner.

Professor von Dietze's book on principles of agricultural policy is divided into four parts. The first part describes the development of applied agricultural policy from its early roots (the Middle Ages and before) to the present. Emphasis is on developments in Europe (both East and West), but China, Japan, and the U.S.A. are discussed as well.

The second part of the book deals with the development of agricultural policy as an academic discipline. About equal space is devoted to accomplishments by German and by international proponents of agricultural policy. This part concludes with a brief review of German agricultural policy texts published since 1945.

The third part concerns itself with the relationship between agricultural policy and general economic policy. Topics such as "agriculture and economic growth," "price formation for agricultural products," "price formation for land," and "agricultural credit" are discussed. These discussions culminate in "conclusions for agricultural policy."

The fourth part of the book is devoted to agricultural policy in the Federal Republic of Germany, emphasizing developments since World War II.

The book is dedicated to Max Sering and intended to continue the latter's school of thought. This explains much of the historical-ethical character of the book. History of agriculture, particularly in the broader sense [p. 128], undoubtedly dominates. In fact, we were left with the nagging question of whether the title of the book should not have been *Principles of History of Agriculture* instead of *Principles of Agricultural Policy*.

In a book dedicated to Max Sering one would expect occasional references to

the "Old Master." These references are there, but possibly in too large numbers and with too much weight. The reader cannot help but get the occasional feeling that what Max Sering thought—or is thought to have thought—is the only criterion of relevance in agricultural policy.

It seems that the European as well as the non-European student of agricultural policy would expect to find a reasonably extensive treatise on agricultural policy in the EEC in a newly published book on principles of agricultural policy in an EEC country. Professor von Dietze's book will not even approximately meet the need of such students. Aside from a few fleeting references to the EEC in various places, the book devotes two and a half pages to the "Impact of the EEC" in Part IV, and about one and a half pages to the EEC and the EFTA in Part I.

Much of the book is devoted to descriptive analysis of a multitude of past events. Since it is primarily a textbook, it should have reduced and condensed this multitude of frequently confusing observations to the more permanent basic relationships which underlie them. The book falls short of accomplishing this. The reason may well be that Professor von Dietze would consider such a reduction of agricultural policy problems to basic principles an atrophying of the discipline [cf. p. 132].

Professor von Dietze emphasizes repeatedly that the discipline of agricultural policy should not be so narrowly defined as to fit into a simplified, sterile, neo-classical, theoretical structure. He argues eloquently and convincingly that agricultural policy cannot exist without consideration of historical, sociological, and ethical dimensions. He also argues that it is not "unscientific" to make explicit consideration of value judgments in policy analysis. These basic tenets are competently supported and consistently adhered to throughout the book.

Although strong emphasis on particular aspects of agricultural policy may not make this book an ideal sole textbook for the typical undergraduate, it can serve as a useful supplemental text and reference book for its areas of strength. For the more seasoned agricultural policy worker and for those who want to learn about the development of the European agricultural structure (with emphasis on West Germany) to its present state, this book is valuable reading.

The book is well written, and in view of the breadth of the numerous topics covered, its organization must be considered excellent.

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Farnsworth, Helen C., and Karen J. Friedmann, "French and EEC Grain Policies and Their Price Effects, 1920-1970," *Food Research Institute Studies*, Vol. VII, No. 1, Food Research Institute, Stanford University, 1967, 140 pp. (\$2.50)

For the first time in its history, an entire issue of *Food Research Institute Studies* is presented as a single monograph. The resulting "book" is quite simi-

lar in size, organization, and approach to the study by the same authors on the West German grain economy published by the Institute in 1966.¹ This earlier publication was a bound reprint of two long articles previously published in *Food Research Institute Studies*. With the completion of the study on French grain policies, scholars concerned with the EEC grain policies and programs have at their disposal two excellent background studies on the major grain producing and consuming members of the EEC, France and Germany.

The authors introduce their monograph by observing:

With [the] introduction of a common grain policy in the European Economic Community in 1962, France reached a cherished goal: preferred access to the markets of member countries and the prospect that the Community would gradually take over all costs of supporting the common grain market, including anticipated large export subsidies on shipments to non-member countries [p. 5].

The authors then state that their study "accounts in some detail for the complex French grain policies behind these developments, and assesses the effects of changing domestic programs on French grain prices and price relationships over the past four decades" [p. 6].

In order to accomplish the above objectives, the book is organized in two major parts. Part I contains a detailed historical description of French grain policies and programs; Part II investigates the influence of government intervention on French grain prices and discusses the outlook for the French grain economy under EEC transitional regulations.

The first part of the book contains an excellent description of the development and implementation of the numerous pricing mechanisms used in French grain programs since the 1920's. The reader is guided through the maze of taxes and payments (statistical tax, storage tax, reabsorption tax, quantum tax, seasonal increment, reduced price, etc.) used prior to the introduction of EEC regulations. The EEC grain price and subsidy program is then described and illustrated in terms of the French grain economy. Table 6 presents a clear summary of the relationships between French domestic grain prices, import and export prices, and corresponding import levies and export subsidies under EEC regulations in effect during July 1965.

Part I also contains a brief description of price and marketing policies for livestock products and a discussion of the direct government costs of recent (1959-1963) price support programs for grain and livestock.

Part II focuses on the influence of government intervention on French grain prices. The analysis is concerned with (a) the historical relationship between French domestic prices and world grain prices and (b) the internal and external changes in price relationships brought about by the EEC regulations. In comparing the EEC period to the pre-EEC situation, the authors conclude that the unified Community prices of agricultural products already scheduled for 1967/68 and 1968/69 mean sizeable increases in French prices to producers of all major grains except maize. . . . These planned prices seem certain to stimulate production of both

¹ Karen J. Friedmann and Helen C. Farnsworth, *The West German Grain Economy and the Common Market: Policies, Prices, and Production, 1925-1975*, Food Research Institute, 1966; reviewed in this journal, August 1967, pp. 768-769.

grain and livestock products, with wheat and barley apparently favored most by the new price-cost structure [p. 107].

The unfavorable price relationships facing French maize (corn) producers are carefully documented by the authors [pp. 98-103]. Apparently, cognizance of these relationships led to the Council of Ministers' October 1967 decision to raise the basic target price for corn, thereby raising the corn-wheat price ratio from 0.85 to 0.89 and at least partially correcting the disparity. Of course, a more favorable pricing situation for French corn producers may eventually be detrimental to U. S. corn exports to the EEC.

One of the work's most important features is a set of seven carefully documented appendix tables which contain a vast amount of historical price information used to support the description and arguments in the text. However, two important omissions hamper the use of the book for future reference. First, the lack of a bibliography makes it difficult to review the vast amount of literature used in preparing the study. The collection of footnotes at the end of the text is a poor substitute for a well-organized bibliography. Second, the omission of an index prevents the rapid location of specific material. However, this omission is partially compensated for by the fairly complete table of contents.

I expect that this book will find its principal audience among researchers and administrators concerned with grain policies and programs in Western Europe. Because of its narrow orientation, the study does not appear suitable for classroom use as a text or reference.

In general, I feel that this book makes a valuable contribution to our knowledge of grain policies and programs in the EEC and particularly in France, the largest grain-producing country of Western Europe.

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Fox, Karl A., *Intermediate Economic Statistics*, New York, John Wiley & Sons, Inc., 1968, x + 568 pp. (\$13.50)

The stated objective of this book is "to integrate a knowledge of relevant statistical techniques with the central problems and concepts of modern economics" [p. 11]. The author expresses the belief that there is a need for such a book because (1) the newer developments in economic statistics have not been satisfactorily integrated into undergraduate instruction, and (2) much graduate instruction in econometrics has emphasized the theory of statistical estimation in isolation from actual problems of economic research.

The unique contribution of this book is its focus on the application of appropriate statistical techniques to important economic problems, the implications of deviation from the assumptions of statistical theory, and the interpretation of statistical analyses of economic problems. *Intermediate Economic Statistics* does not have the heavy emphasis on derivations and proofs that one expects in a statistical theory or econometrics textbook. Neither does it emphasize

the step-by-step recipe approach found in statistical methods textbooks. Instead, each statistical technique is discussed within the context of the particular types of economic research problems to which it is applicable, and emphasis is placed on problems of estimation and interpretation.

The organization is logical and the order in which topics are presented is such that chapters could be taken in order if the book were being used as a course text. The first three chapters contain introductory material, including brief reviews of economic and statistical concepts. Chapters 4, 6, and 7 treat simple and multiple regression analysis, with emphasis on the difference between the regression model and the correlation model. Chapter 5 deals with index numbers and time series from the traditional viewpoint; Chapter 9 emphasizes the multivariate approach to time series. Chapter 8 contains a very brief treatment of the analysis of variance as related to regression analysis. The construction of large-scale models is discussed in Chapter 10, with the Klein-Goldberger and the Brookings Institution-S.S.R.C. models used as examples. The identification problem, causal ordering, estimation techniques, multicollinearity, and the use of *a priori* information in multiple-equation models are treated in Chapters 11-13. Chapter 14 deals with the measurement of economic aggregates.

The background required for reading the book includes an understanding of basic economic principles, an introductory course in statistical inference, and the fundamentals of matrix algebra. Although the basic concepts of economics and statistics are reviewed in Chapters 2 and 3, the student with no previous training would find these chapters inadequate. Matrix algebra is a prerequisite to reading only Chapters 12 and 13. In the rest of the book ordinary algebraic notation is used except in appendices. The author relies heavily on examples both to illustrate concepts and to demonstrate relationships that would normally be proven mathematically in a book assuming a higher level of mathematical competence on the part of readers. The generous use of examples may make the presentation seem rather laborious for the more mathematically inclined reader but will increase the usefulness of the book for many readers.

The book is well written and unique in its focus. The coverage of the book is probably too broad for a one-semester course. The first nine chapters might be covered in an advanced undergraduate course, while Chapters 5 through 14 might be included in a graduate-level course. Since some topics are discussed only briefly, the teacher would probably want to supplement the volume with a more traditional statistics or econometrics text. This book may be most useful as a supplementary text for graduate-level econometrics courses in which the principal text is more theoretically oriented. Professional economists using statistical techniques will also find this a useful reference.

T. KELLEY WHITE
Purdue University

Goldberg, Ray A., *Agribusiness Coordination: A Systems Approach to the Wheat, Soybean, and Florida Orange Economies*, Boston, Harvard Business School, 1968, xix + 256 pp. (\$12.00)

This study is an extension of the original purpose of the Agriculture and Business Program at the Harvard Business School, as outlined in the publication *A Concept of Agribusiness* by John H. Davis and Ray A. Goldberg, published in 1957. Thus, the present study moves from the description of the total agribusiness economy to a schematic analysis of the ever-changing structure and performance of a widely divergent group of commodity systems—wheat, soybeans, and Florida oranges.

The central concept behind this study is that if managers, private and public, are to develop effective strategies and policies, they must be fully aware of the total commodity system in which they operate, and they must understand the interaction of its parts. The purpose of the report is to illustrate and develop this concept, and to present, analyze, and evaluate a commodity systems approach to agribusiness industries.

An agribusiness commodity system, as defined by the author, encompasses all the participants involved in production, processing, and marketing of a single farm product. Such a system includes farm suppliers, farmers, storage operators, processors, wholesalers, and retailers involved in a commodity flow from initial inputs to the final consumer. It also includes all the institutions which affect and coordinate the successive stages of a commodity flow, such as the government, futures markets, and trade associations.

Although each of the commodity systems selected for this study has unique structural and performance patterns, the analysis of the three systems, taken together, has general application for managers in all agribusiness commodity systems.

The study, containing 12 chapters, is divided into five sections. The introductory section of two chapters is followed by sections covering the three commodity systems: Sections II, III, and IV cover the wheat, soybean, and Florida orange commodity systems, respectively. Each section deals with the structure of the commodity system, including channels of product flow, numbers of firms and entities, ownership patterns, and marketing systems. The behavior and performance of each commodity system then is examined and analyzed.

In Section V a number of critical trends are identified which will affect agribusiness systems in the future. The final chapter discusses the major conclusions in terms of challenges and opportunities for private and public managers involved in these and other agribusiness commodity systems.

Agricultural businessmen were challenged in the report to (1) develop an industry intelligence network which will provide the participants with greater understanding of the interrelationships of the parts of the system and major ramifications of certain types of private and public policies, (2) develop better types of trade associations, (3) recognize that the very nature of the supply process will mean continued government programs, (4) be bolder in the use of present and future ways of meshing their firms' operations into the total com-

commodity system through better use of markets, new contractual arrangements, futures markets, vertical integration, and new forms of business organizations, (5) broaden their conception of the industry system constantly and recognize that the ultimate market of each firm and industry is made up of domestic and international food consumers who think in terms of diverse and changing styles of living rather than in terms of wheat flour, soybean oil, or orange concentrate.

Although this new book is obviously a sturdy contribution to the area of total systems analysis as opposed to the individual firm analysis, this reviewer would have preferred that the systems had been broad enough to include closely substitutable products, with separate analyses covering food grain, oil seeds, and citrus fruits rather than wheat, soybeans, and Florida oranges. A need exists for making the same application to the other agribusiness industries, including poultry meat, red meats, eggs, milk, cotton, and vegetables.

The report tended to play down the power of the individual firm over the external environment in the commodity system itself and certainly outside the commodity system. Perhaps the firm of the future is one that will not adapt to the environment but will change the environment to fit the peculiarities of the firm.

In the main, I was pleased with the book; it is forward looking and emphasizes the need for future studies to be on an industry or systems basis, with some emphasis on the individual firms. The need for additional vertical coordination by ownership or contract was apparent. Many of the important problems of agriculture (surpluses, farm income, bargaining power) can best be analyzed in the context of the commodity systems approach.

Business and government leaders responsible for long-range planning, educators engaged in analyzing the many sectors of agribusiness, as well as those groups and individuals affected by or interested in the evolving developments in commercial agriculture and agribusiness, should find this book useful.

HILLIARD JACKSON
University of Arkansas

Hardin, Charles M., *Food and Fiber in the Nation's Politics*, Vol. III, Technical Papers of the National Advisory Commission on Food and Fiber, Washington, U.S. Government Printing Office, 1967, xi + 236 pp. (75¢ paper)

The author of this report is a professor of political science and director of the International Agricultural Institute at the University of California, Davis. He was commissioned to write on the administration of past federal agricultural programs as part of the overall study by the National Advisory Commission on Food and Fiber. His analysis covers federal policy with respect to agricultural trade and development, farm prices, soil conservation, and agricultural science. The author concerned himself in particular with the problem that Congress and the President face in controlling the administrative agencies established to carry

out their policies. The problem arises from the immense size of the agencies and the broad-based support which they have obtained from the organized beneficiaries of their programs, their clientele.

Over all, Professor Hardin is quite critical of U.S. agricultural policy and its administration. He criticizes U.S. agricultural trade policy for being protectionist and for surplus dumping (P. L. 480). He criticizes U.S. agricultural price support and soil conservation programs, as administered, for favoring the organized, prosperous, white farmers. He criticizes U.S. agricultural science policy for the increasing fragmentation of its financial support. This stems from increasing Congressional scrutiny of research projects, the growth of advisory committees, and the trend to short-term grants and contracts in lieu of long-term grants-in-aid to the states on a formula basis. He fears that this trend may tend to concentrate the funds on the more fashionable approaches in the more prestigious schools and spawn a group of foot-loose research entrepreneurs moving in response to the best offers.

Readers will likely be surprised to find how much could be wrong with apparently well-intended programs passed and administered by a democratic government. One wonders whether we need more democracy or less, or perhaps a change in human nature.

Ironically, features associated with our price support and soil conservation programs, of which the author was critical, were what he found were needed in conjunction with our agricultural science and foreign technical assistance programs. Although Congress has lost some of its control of the price support and soil conservation programs because of the political strength of the programs' clientele, he states that the foreign technical assistance program is endangered from the very lack of such a politically effective clientele. And although the author stressed the need for greater control by the legislative and executive branches over the price support and soil conservation programs, he was fearful of their increasing scrutiny and control of funds for agricultural research. Is it possible to have it both ways or is it a matter of balance?

Over all, the report was an excellent piece of work from a very knowledgeable scholar and a report well worth the time of anyone interested in the problem of responsible and accountable government in general and in U.S. agricultural policy in particular.

JOHN R. MOORE
University of Maryland

Marks, Norton E., and Robert M. Taylor, eds., *Marketing Logistics: Perspectives and Viewpoints*, New York, John Wiley & Sons, Inc., 1967, 289 pp. (\$8.95)

This book of readings presents managerial ideas about a new way of looking at existing business structures and operating methods, called *logistics*. Logistics is the study of market-oriented coordination in business to get the right amount

of product to the right place at the right time. In attempting to perform this task, business management gets involved in an attempt to balance several divergent business factors. Basically, through better distribution practices, managers are trying to give greater customer service, but at a lower relative cost. This book presents a collection of articles by some of the foremost academic, and business, authors on this subject.

Contributors point out that the activities encompassed by logistics are not new to business. On the contrary, distribution activities are as old as business itself. The new idea entailed in logistics is its focus on the interrelated flow of information and materials and on the organizational concepts needed to achieve this focus.

The seven sections in this book are logically ordered for progressive insight as the reader goes through them. Background for an acquaintance with the role of logistics in the economy is presented first. The next five sections then present the integral parts which constitute the discipline of logistics. These include customer service, facility location, information flows, packaging, materials handling, storage, inventory management, and movement services. The last section presents synthesizing articles that point out the interrelationships within marketing logistics.

The articles in these sections present a wide range of offerings. They vary from description to analysis, example, and operative models. They also vary quite widely from quantitative to qualitative and from specific to general. The operative precision and the overall viewpoint sought in logistical operations are both explained from several points of view.

Marketing Logistics is a fine introduction for upgrading the advanced student's general knowledge and vocabulary of the conceptual field of logistics. It covers the manager's viewpoint, and it does not get lost in the internal controversies of the developing logistics field. In general, the articles assume a reader knowledge of normal business organization and operations. A few of the more technical articles, requiring a knowledge of mathematical notation and systems analysis, will appeal to the professional economist.

Current trends in business are making the knowledge of logistical concepts a requisite for modern businessmen. The editors of this book have done a good job of selecting a range of current articles and authors for introducing business decision makers to logistics concepts and practices.

GLEN R. FERLEMANN
Kansas State University

Miller, Clarence J., ed., *Marketing and Economic Development: Readings in Agribusiness Research*, Lincoln, University of Nebraska Press, 1967, xi + 422 pp. (\$3.25)

This is a collection of 22 papers on selected aspects of agricultural marketing. It was intended as a convenient source of readings for students in courses

oriented toward agricultural marketing research. The papers are organized into six categories: (1) Foreign Marketing and Economic Development, (2) Market Power and Prices, (3) Transportation and Plant Location, (4) Demand, Supply and Consumption, (5) Firm Decision Making and Competition, and (6) Marketing Research. The editor has provided a brief introduction to each section and a list of supplementary references. Most of the papers were written by agricultural economists and were originally published in the *Journal of Farm Economics*, the *Proceedings* of the Western Farm Economic Association, or the *Stanford Food Research Institute Studies*. The supplementary reading lists give good coverage to articles in the *Journal of Farm Economics* for the period of 1956-1966, with an occasional reference to other journals.

Those who expect to find an elaboration of the role of marketing in economic development will be disappointed. Papers by J. C. Abbott (*JFE*, 1962) and William Foltz (WFEA, 1964 *Proceedings*) provide an orientation to the problems of market organization in the less-developed countries. Helen Farnsworth's paper points up some of the difficulties in using comparative data on national food supply and consumption (*Food Research Institute Studies*, 1961). Most of the other papers relate to the U.S. economic environment, although the research methodologies, such as spatial equilibrium analysis, and procedures for estimation of supply parameters have more general relevance.

In my opinion, the most useful contribution made by this collection of papers is to assemble in a convenient package some of the better *JFE* articles critically evaluating our professional efforts as marketing researchers. Papers by Charles French, James Shaffer, Ed Schuh, H. S. Irwin, and Richard Kohls point up some of the shortcomings of our past efforts and offer suggestions for future research. However, missing from the list of readings are papers by R. G. Bressler and M. M. Kelso which offer cogent commentaries on the general orientation of agricultural economics research (*JFE*, Vol. 47).

The most disappointing thing about this collection of readings and the related lists of references is the paucity of relevant writings on marketing as an integral part of the dynamic process of economic growth. The articles that have been published in the *JFE* reflect the preoccupation of agricultural marketing economists with problems of resource use efficiency and equity. Although some of these efforts have no doubt been useful, relatively little has been achieved in dealing with the central issues of economic development and the role of the marketing system in fostering the coordination of the agricultural-industrial complex. This reorientation of our professional efforts seems to be needed not only in less-developed countries but also in dealing with the rapid reorganization of agricultural industries here in the United States.

HAROLD M. RILEY
Michigan State University

Nakamura, James I., *Agricultural Production and Economic Development of Japan, 1873-1922*, Princeton, N.J., Princeton University Press, 1966, xxiii + 257 pp. (\$7.50)

James Nakamura's book is a provocative contribution to economics. By concluding from a critical examination of the official Japanese agricultural statistics that agricultural output has been underestimated, he has cast shadows of doubt upon previous development theories and historical interpretations based on these statistics. In Nakamura's view, early agricultural production in Japan was higher than previously believed, creating an agricultural surplus in the initial stages of development which was available for transfer to the industrial sector.

Nakamura derives a new set of agricultural statistics (1878-1882 and 1913-1917) and states that agricultural output increased at an average rate of about 1 percent a year, a direct challenge to the average annual growth rates derived by Bruce F. Johnston (1.8 percent), Saburo Yamada (1.9 percent), and Kazushi Ohkawa (2.4 percent).

The evidence which Nakamura uses to support his thesis is derived from his evaluation of the effects of the original cadastral survey taken between 1873 and 1879. According to Nakamura, during the land survey, farmers under-reported their crop yield in order to avoid taxes by (1) concealing arable land, (2) undermeasuring arable land, and (3) under-reporting yield.

Between 1885 and 1890 total arable land increased from 4,514,000 cho (one cho equals 2.45 acres) to 5,030,000 cho, or 11.4 percent. This unusual increase was found in a second land survey taken from 1886 to 1889, which was accompanied by harsh fines against those found trying to conceal land and waiver of the fine for voluntary disclosure. Nakamura compares this 11.4-percent increase to the amount of land reclamation during the period, which was negligible, and concludes that the reported increase in arable land was due to registration of previously unregistered land or the proper classification of previously misclassified land.

Undermeasurement of land was a historical practice to avoid taxes, and Nakamura cites some common examples. To compensate, he established an index and increased the amount of arable land by 6.9 percent for paddy fields and 4.9 percent for upland fields.

The incentive for farmers to under-report yields was the fear that land might be revalued with yield as a determinant of value. Nakamura rejects the Meiji 1870 average rice yield of 1.32 koku per tan¹ because this amount is about equal to the average yield reported two centuries earlier. He re-estimates the yields as 1.5-1.7 koku for the 1873 period, increasing to 1.9-2.0 koku per tan by the 1918-1922 period.

The conclusion that agricultural production rose much more slowly than previously estimated questions the relevance of the proportions on transfers of labor and of capital funds to the nonagricultural sector during the Meiji period

¹ One koku equals 4.96 bushels; 10 tan equal one cho, which equals 2.45 acres.

as postulated by Bruce F. Johnston, Kazushi Ohkawa, Gustav Ranis, and Henry Rosovsky

Since the absolute amount of the agricultural labor force remained approximately constant over the Meiji period (1868–1912), Nakamura's lower rate of output growth implies that agricultural labor productivity (measured per man per year) must also be lower. Transfer of labor is dependent on the increase in labor productivity as well as population increases; so Nakamura's lower labor productivity figures would mean that less labor was available for transfer to the industrial sector over the Meiji period. To account for flows of labor greater than allowed by the population and productivity constraints, Nakamura contends that surplus agricultural labor developed, was immobilized during the late Tokugawa period,² and then was released for migration to the industrial sector by the Meiji Restoration. The argument is plausible but weak, since we do not know how much surplus labor did, in fact, exist.

A stronger argument that Nakamura presents is that the Samurai class, a warrior class highly educated and trained in leadership, could be considered surplus labor. During the Meiji period, the Samurai were forced by a decline or loss of their stipends to seek employment in all sectors of the economy, an action possible because of the breakdown of the feudal caste system. The Samurai class made up approximately 7 percent of the total population; so it is very likely that this induced input, stemming from the Japanese feudal system rather than from an agricultural base, may be one of the key elements in explaining why the Japanese pattern of development differs greatly from that in other developed and developing nations.

The shift of nonhuman resources as seen through Nakamura's production estimates takes on new dimensions. Most Japanese economic historians believe that a substantial part of national savings was created in the agricultural sector by the high rates of increase in agricultural production. Nakamura questions whether there was saving in the agricultural sector but does argue that there probably was increased saving in the early Meiji period:

The Meiji land reform caused a major redistribution of income from the Samurai class to the landowning class. The redistribution probably caused substantial increase in the rate of savings because the landowning class was likely to have had a considerably higher propensity to save [p. 173].

In this case, behavioral patterns are reversed from what we would expect on the basis of Keynesian saving theory, since, on the average, the landowning class had lower income than the Samurai. The paucity of savings by the Samurai class was due to the effects of the Sankin Kotai system.³ Nakamura concludes that savings probably rose for the economy during the early Meiji period. It should also be pointed out that the Meiji Restoration meant the end of the Sankin Kotai system (an end to forced consumption); so the savings pat-

² The House of Tokugawa ruled Japan between 1603 and 1868.

³ The obligation imposed upon the Samurai to reside for a part of each year in Edo (now Tokyo). An attitude of "keeping up with the Joneses" prevailed, and many of the Samurai class became indebted to the Chōmin (merchants). This system was used by the Tokugawa to keep the Samurai financially and politically weak.

terns changed for the Samurai as well as for the landowner class. Nakamura does not attempt to explain the savings pattern in the later Meiji era, a time period just as relevant for explaining the Japanese economic transition from an agrarian to an industrial society as the earlier period.

Nakamura shows clearly that Ohkawa's growth rate for agricultural production, 2.4 percent a year, is too high. However, his own growth rate of 1.0 percent a year seems too low. He states that rice consumption over the 40-year period increased at the same rate as food production. Accounting for imports and exports of rice, a 1.0-percent increase in rice production would approximately equal the population increase, meaning that the income elasticity of rice was close to zero and per capita rice consumption remained steady or declined during the Meiji period. Since rice was considered a preferred food and inferior substitutes were consumed by lower income groups, a near-zero income elasticity for rice seems very unlikely with the general rise of real per capita income in Meiji Japan.

In a recent article, Henry Rosovsky⁴ concedes that the older Ohkawa growth rate (2.4 percent) was too high and suggests a growth rate of 2.0 percent per year. It seems that the rate of increase in agricultural production from 1878-1882 to 1913-1917 ranged between 1.0 percent and 2.0 percent, with the difference to be further debated. Until the difference is resolved, we can expect confusion and controversy on the interpretations of Japanese economic history based on the official Japanese agricultural statistics.

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⁴ "Rumbles in the Ricefields: Professor Nakamura vs. the Official Statistics," *Asian Studies* 27:347-360, 1968.

Southworth, Herman M., and Bruce F. Johnston, eds., *Agricultural Development and Economic Growth*, Ithaca, Cornell University Press, 1967, xv + 608 pp. (\$12.00)

With peasant unrest and guerrilla warfare in the countryside, population pressures on the few land resources left for the millions of little peasants, traditional rural societies preventing a dynamic growth of agriculture, governments devoting more of their budgets to fighting the guerrillas than to strengthening the peasantry; with serious social scientists predicting famines and publicity seekers aping them—why, agricultural development has become a revolutionary or (if you don't like the term) explosive issue on which the fate of nations seems to depend more directly than on (say) mere industrialization or outside technical and financial assistance.

But of this drama *Agricultural Development and Economic Growth* reveals little. If this book of essays had appeared 10 or 15 years ago, it might have

found more applause in the United States than it may get in the late 1960's. Even less advanced students of agriculture for whom the book seems mainly to be intended will be frustrated: the urgency with which the rural problem presents itself in the real world is not reflected here. The sophisticated reader outside the United States, if he lives in one of the developing countries, is likely to reject it because it sidesteps many crucial issues of social and economic growth debated there.

Agricultural Development just does not seem to be fully in step with the concerns of our time, nor does it throw much light on the problems which will face us if agricultural growth, however defined, fails to develop.

Still the book is finely conceived and a "must" for the professional's bookshelf. It gives an inkling of the complexities of how to bring about agricultural growth and what this implies. The essays are written by some of the most respectable members of the profession, most of them from the United States. It is a valuable source of reference for American and some foreign literature. And it is oriented toward an analysis of the institutional components of economic growth, an orientation which gives the volume a more earthy quality than it would have if it were composed mainly of the type of mathematical functions which Earl O. Heady introduces in the hope of clarifying his discussion of the importance of farm size in economic development.

The original idea of the editors to present the various growth issues in a controversial format by allowing critics to review the 14-odd lead articles—such as "Towards a Theory of Agricultural Development" or "The Economics of Farm Size," to name only two—ought to have allowed a livelier discussion and made the book more interesting reading. But conception is one thing, execution another. Recently in Mexico two men bound together by long friendship passed a large pile of rocks. Admiring this natural resource—so the newspaper story goes—they began throwing the rocks at each other, friendly-like, ending their bout with fractured skulls in the hospital. No such slugfest in *Agricultural Development*! Instead, it turns out to be a fashionable cocktail party, in the home of a friendly host. The invited guests treat each other in a gallant manner—one critic is "full of admiration for an ingenious effort" of one essayist; another focuses on the "rich fund of knowledge acquired" by another—and avoid references to what could arouse heated conversation of a controversial nature. If disagreement exists—take for example D. Gale Johnson disagreeing "substantially" with Krishna with respect to the latter's espousal of the complete average cost as the basis for establishing support prices—then it remains more apparent than real, or turns around marginal facets of the issues under discussion. Among the few exceptions is Barraclough, who manages to introduce a bit of sex—of course not a marginal factor in rural growth—into his intelligent and pointed notes on the otherwise sexless theories of farm size. The overall result is that this revolutionary theme, agricultural development, becomes about as pallid as the wax statue of Jack-the-Ripper in Madame Toussaud's Museum in London.

But why (with a few exceptions such as Wharton's essay on the infrastructure of growth and Krishna's on agricultural price policy) is so much of this book disappointing? Some of the contributions just do not add much that is new. Take the key essay, "Traditional Social Structure as Barrier to Change,"

written by the late John M. Brewster, one of the pioneers of American institutional agricultural economics. It contains only fair, even unconvincing material, in part because of the author's exaggerated emphasis on little Taiwan, where rural development does not contain as much of a lesson for the developer as the author implies. R. P. Dore's *Land Reform in Japan* is many times more instructive on the same topic. Or take George Montgomery's "Education and Training," written at a low level of sophistication. Or Ojala's fine contribution on "The Programming of Agricultural Development": he stays in the realm of abstraction by failing to examine economic planning in the real Western developing world. Usually planners are limited to the unearthing of additional knowledge on the performance of their economies: in their political impotence they receive well-earned salaries and spend institute-budgets on secretaries and on filing-cabinets in which to bury their production. Programming is quite a job; but it is how to make the programs effective which is problematic.

Several authors show an uncritical belief that there exists a world in which there is perfect competition, resource allocations are guided by the price system, economically rational decisions are made by profit-maximizing estate owners and peasants all thrown together, and the millions of laborers (wondering whether they will have enough rice or corn to eat on the following day) choose between work and leisure. To be sure, some concessions to the importance of institutional arrangements are made even by these economists, but the destruction which such concessions cause to the original "classical" position is not brought out. Perhaps resource allocations are not made principally in response to economic forces, but instead result from the interplay of power politics¹ or simply from ancient traditions. It would have been worthwhile to include a short essay on the relative importance of the various forces which shape growth rather than making half-hearted attempts at compromises between philosophies which have all the appearance of being incompatible.

Some arguments in the book are hardly defensible. Raup states in his article on land reform that "most developing countries are too poor and too desperately in need of increased food output to risk a distribution of land to all the landless" [p. 301].² This reasoning is heard more often from estate owners than from land reformers because they naturally put production ahead of social reforms. For most underdeveloped nations, poverty and lack of food are the result of a defective land tenure structure. It is like saying that a patient, suffering from a case of acute appendicitis, with a six-day fever of 105 degrees, is too weak to go through the operating room. Or take Dore's unqualified statement that Bolivia's land reform is a failure [p. 325] even though it liberated the Indian peasantry from centuries of serfdom. Or the Burk-Ezekiel claim that in the developed regions, even the poorest families had enough food energy [p. 337]. This is contradicted by, for example, recent reports on the level of living of Negroes in parts of the United States.³ Their error could arise from uncriti-

¹ An interesting contribution in this area is the recent book by Harold Niebuhr, *In the Name of Science*, Chicago, Quadrangle, 1966.

² If Raup's emphasis were on the word "all," it would be more defensible. But who has ever claimed that *all* landless people should have land?

³ "Starvation in Mississippi," *New York Times*, March 26, 1968, p. 44. See also

cally accepting aggregate statistics, but professionals normally do not do this.

There is also much that is *not* in the professionally competent material of the volume. It is an unfair trick of reviewers to criticize a book on the basis of what is not in it. In this case, however, the picture painted by *Agricultural Development* just is not well rounded for the reader of 1968 whose curiosity has been aroused about agriculture, the role of assisting and assisted nations, the growing gap between them. Will he learn much about what development means? About the real interrelationships in growth between the major sectors of society? And how various strategies of development affect each sector? Fortunately there is Mellor's eloquent discussion of the theories of the role of agriculture in economic development and their shortcomings. Mellor touches on these questions but does not furnish many answers. He, like other authors in the volume, complains that there is not enough empirical evidence to elaborate a really all-inclusive, all-explaining theory of development (hence his cautious title "Toward . . ."). But surely this ignores the outpouring of economic, statistical, sociological, political, legal, business-management, and even literary writings on both sides of the bamboo, iron, and other curtain: and in the third world, which has no equal in the history of mankind. Perhaps some evidence could have been found in the analyses of the development of agricultures such as those in Italy, Mexico, Yugoslavia, Greece, Cuba, India, or mainland China, most of which are ignored in the essays. I suspect that one possible explanation for the repeated reference to lack of empirical data is that the data we most like to use do not fit any available and acceptable nonpolitical, theoretical straightjacket. If this is heresy, it ought to have been exposed by the critics. For example, what economic model can explain the phenomenon of Mexico? There, land reform has given a great deal of land—although not as much as it ought to have given—to "the men who work it"; agriculture subsequently has set production records to the satisfaction of the farm-management-minded, but the majority of the *campesinos* continue to be underemployed, to the worry of the sociologists; and the merchant sector devours a lion's share of the increased agricultural income.⁴

And does development mean the same thing to the developed and the underdeveloped countries? In a short and brilliant article, "Counterrevolutionary America," Robert Heilbroner questioned recently whether the United States is fundamentally opposed to economic development.⁵ This is a basic question on which much of the literature of the third world is focused. It involves such issues as the following: what effects foreign investment, processing firms, and marketing firms have on resource allocation in the underdeveloped economies; whether their activities benefit the local peasantry or local agriculture more than they benefit foreign investors; in short, whether foreign investors have any influ-

W. H. Locke Anderson, "Trickling Down: The Relationship Between Economic Growth and the Extent of Poverty Among American Families" *Quart. J. Econ.* 78:511-524, Nov. 1964.

⁴ M. Edel and J. Ballesteros, *The Colonization of Papaloapan*, to be published shortly by the Centro de Investigaciones Agrarias (Mexico). The authors found that after 12 years of operation the merchants captured 44 percent of the income generated in the project and the *campesinos* live at subsistence levels.

⁵ *Commentary* 43:31-38, April 1967.

ence on the planning, programming, employment, and capital allocation which take place there. Timely questions which might have been overlooked 15 years ago, but can hardly be ignored in a treatment of agricultural development in the late 1960's.

Finally, we look in vain for some insights into the role of the people for whose final benefit this book is presumably written. With a few notable exceptions—Raup's analysis of the impact of tenure changes on the decision-making ability of farm people, and Wharton's opening comment that a key element in the process of development is the human factor, a comment which he unfortunately does not elaborate—the peasants who work the land, feed people, and buy the products of industry remain phantoms. Astonishing, when one recalls that, in many cases, rural development, even if it comes in small doses, has taken place only after farm people have had to take matters into their own hands and demonstrate that they are "a factor" affecting development!⁶

ERNEST FEDER

Economic Commission for Latin America

⁶ As I tried to show in my article, "The Milkers' Unions of the San Francisco and Los Angeles Milksheds," *J. Farm Econ.* 32:458-477, Aug. 1950.

CORRECTION

In Ernest Feder's review of the CIDA report, *Land Tenure Conditions and Socio-economic Development of the Agricultural Sector* [*Am. J. Agr. Econ.* 50:460-462, May 1968], it should have been noted in the title that the report on Argentina was published in both English and Spanish and that on Brazil in both English and Portuguese. The same correction applies to the original listing in the *Books Received* section of the November 1967 issue [p. 966].

Books for listing in this section should be sent to the Book Review Editor (see inside front cover for address).

Books Received

- Ashton, J., and S. J. Rogers, eds., *Economic Change and Agriculture*, Edinburgh, Oliver and Boyd, Ltd., 1967, vi + 360 pp. 42s.
- Christy, Francis T. Jr., and Anthony Scott, *The Common Wealth in Ocean Fisheries*, Baltimore, The Johns Hopkins Press for Resources for the Future, Inc., 1965, xiii + 281 pp. \$6.00.
- Clawson, Marion, *The Land System of the United States: An Introduction to the History and Practice of Land Use and Land Tenure*, Lincoln, University of Nebraska Press, 1968, ix + 145 pp. \$3.75.
- Dent, J. B., and H. Casey, *Linear Programming and Animal Nutrition*, Philadelphia, J. B. Lippincott Co., 1968, vii + 111 pp. \$7.50.
- Dillon, John L., *The Analysis of Response in Crop and Livestock Production*, New York, Pergamon Press, Ltd., 1968, xiii + 135 pp. \$4.50.
- Gerschenkron, Alexander, *Continuity in History and Other Essays*, Cambridge, Mass., The Belknap Press of Harvard University Press, 1968, x + 545 pp. \$10.00.
- Goldberg, Ray A., *Agribusiness Coordination: A Systems Approach to the Wheat, Soybean, and Florida Orange Economies*, Boston, Harvard University Graduate School of Business Administration, 1968, xix + 253 pp. \$12.00.
- Hidreth, R. J., ed., *Readings in Agricultural Policy*, Lincoln, University of Nebraska Press, 1968, xv + 563 pp. \$3.95 paper, \$6.95 cloth.
- Holloway, Robert J., and Robert S. Hancock, *Marketing in a Changing Environment*, New York, John Wiley & Sons, Inc., 1968, ix + 498 pp. \$7.95.
- Houthaker, Hendrik S., *Economic Policy for the Farm Sector*, Washington, American Enterprise Institute for Public Policy Research, 1967, vii + 65 pp. \$2.00.
- Humbert, Roger P., *The Growing of Sugar Cane*, rev. ed., New York, American Elsevier Publishing Co., Inc., 1968, xii + 779 pp. \$42.50.

- Kristensen, Thorkil, *The Food Problem of Developing Countries*, Paris, Organization for Economic Co-operation and Development, 1968, 114 pp. Price unknown.
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- Moore, John R., and Frank A. Padovano, *U. S. Investment in Latin American Food Processing*, New York, Frederick A. Praeger, Inc., 1967, xiii + 208 pp. \$15.00.
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- Padberg, Daniel I., *Economics of Food Retailing*, Ithaca, N.Y., Cornell University, 1968, xi + 292 pp. Price unknown.
- Pincus, John A., ed., *Reshaping the World Economy*, Englewood Cliffs, N.J., Prentice-Hall, Inc., 1968, xii + 176 pp. \$4.95 cloth, \$1.95 paper.
- Rossmiller, George E., *The Grain-Livestock Economy of West Germany with Projections to 1970 and 1975*, Res. Rep. 1, East Lansing, Institute of International Agriculture, Michigan State University, 1968, xi + 253 pp. \$2.00.
- Saylor, Ralph G., *The Economic System of Sierra Leone*, Durham, N.C., Duke University Press, 1968, xii + 231 pp. \$10.00.
- Simpson, Morag, and A. R. El Hadari, *Milk Production and Marketing in the Tropics: A Case Study Based on Khartoum Province, Sudan*, Khartoum North, University of Khartoum, 1967, xiv + 183 pp. Price unknown.
- Slesinger, Reuben E., ed., *National Economic Policy: The Presidential Reports*, Princeton, N.J., D. Van Nostrand Co., Inc., 1968, ix + 245 pp. \$2.95.
- Smith, Robert H. T., E. J. Taaffe, and L. J. King, eds., *Readings in Economic Geography, the Location of Economic Activity*, Chicago, Rand McNally & Co., 1968, 406 pp. \$6.00.
- Tintner, Gerhard, *Methodology of Mathematical Economics and Econometrics*, Chicago, University of Chicago Press, 1968, ix + 113 pp. \$4.75.
- Transportation: The 1970's*, January 17-18, 1968, Conference Proceedings, UGPTI Rep. 1, The Upper Great Plains Transportation Institute, Fargo, North Dakota State University, 1968, iv + 125 pp. \$2.00.

796 / BOOKS RECEIVED

Weaver, J. E., *Prairie Plants and Their Environment: A Fifty-Year Study in the Midwest*, Lincoln, University of Nebraska Press, 1968, ix + 276 pp. \$6.95.

Whetham, Edith H., *Co-operation, Land Reform and Land Settlement*, London, The Plunkett Foundation

for Co-operative Studies, 1968, xi + 79 pp. 12/6.

Wightman, David R., *Food Aid and Economic Development*, International Conciliation No. 567, Carnegie Endowment for International Peace New York, Taplinger Publishing Co., Inc., 1968, 72 pp. \$0.60.

Announcements

WINTER MEETING AMERICAN AGRICULTURAL ECONOMICS ASSOCIATION WITH ALLIED SOCIAL SCIENCE ASSOCIATIONS

December 27-30, 1968, Chicago

Joint meetings with a number of other social science associations will be held in Chicago, December 27-30. Headquarters will be the Pick-Congress Hotel. Tentatively, sessions are scheduled as follows:

Supply Function in Agriculture, Revisited. Joint with AEA.

The Potential Role of Control Theory in Policy Formulation for the U.S. Agricultural Industry. Joint with ES.

Agribusiness and Other Agricultural Economists: Complementary, Supplementary, or Competitive?

Technology, Demography, and U.S. Rural Economic Policy

At a luncheon Dr. Joseph Ackerman, Managing Director, Farm Foundation, will review the role of foundations in sponsoring and contributing to work in agricultural economics.

Local arrangements are being made by a committee chaired by W. E. Hamilton of the American Farm Bureau Federation.

1969 ANNUAL MEETING

The 1969 annual meeting of the AAEA is tentatively scheduled for August 17-20 at the University of Kentucky, Lexington. John C. Redman is chairman of local arrangements and will welcome all suggestions. Harold F. Breimyer, Department of Agricultural Economics, University of Missouri, Columbia, invites ideas and proposals as to the program.

DUES

Dues for 1968 are payable. The dues rate is as follows:

American Agricultural Economics Association—\$10.00

Junior Membership, AAEA—\$5.00 (Graduate Students, 3-year maximum)

Joint Membership, AAEA, and WAEA—\$12.50

Joint Membership, AAET and CAES—\$16.50

Joint Membership, AAEA, WAEA, and CAES—\$19.50

Please mail your check, payable to the American Agricultural Economics Association or AAEA, to C. D. Kearn, Secretary-Treasurer, AAEA, Department of Agricultural Economics, Cornell University, Ithaca, New York 14850.

BACK ISSUES OF *JOURNAL OF FARM ECONOMICS* NEEDED

The secretary-treasurer of the AAEA is authorized to pay \$1.00 each for any of the issues of the *JFE* listed below.

<i>Year</i>	<i>Volume</i>	<i>Issues</i>	<i>Year</i>	<i>Volume</i>	<i>Issues</i>
1919	1	1, 2, 3	1951	33	1, 3
1920	2	1, 2, 3, 4	1953	35	1, 5
1921	3	1, 2, 3, 4	1954	36	2, 3
1922	4	1, 2, 3, 4	1955	37	1, 2, 3, 4, 5
1923	5	1, 2	1956	38	1, 2, 3
1924	6	1, 2, 3, I	1957	39	2
1925	7	1, 2, 4, I	1958	40	2
1926	8	1, 2, 3, 4, I	1959	41	1, 3
1935	17	1	1960	42	1, 4, 5
1943	25	1, 2, 3, 4	1961	43	2, 3, 4-2
1944	26	2, 3	1962	44	1, 3
1945	27	1, 2, 3, 4	1963	45	1, 5
1946	28	1, 2, 3	1964	46	2, 3, 5
1947	29	1, 2	1965	47	1
1948	30	1	1967	49	1-1, 1-2

JOURNALS should be mailed to C. Del Mar Kearn, AAEA, Department of Agricultural Economics, 455 Warren Hall, Cornell University, Ithaca, New York 14850.

News Notes

PERSONAL

Harry W. Ayer, candidate for the Ph.D. at Purdue University, is in residence with the Secretariat of Agriculture, Sao Paulo, Brazil, doing research under a Ford Foundation grant.

F. Raeford Baker has recently joined the staff of the Agricultural Policies Division of the Organisation for Economic Cooperation and Development in Paris, France. He was formerly employed as an instructor in the Department of Agricultural Economics and Agribusiness at Louisiana State University.

Calvin R. Berry, on leave from the University of Arkansas, will be visiting professor in the Department of Agricultural Economics, University of Minnesota, from June 1 to December 31, 1968. He will work in the area of dairy policy during the absence of Dr. Martin K. Christensen, who is presently on leave with the Economic Research Service, USDA. Dr. Berry will also be associated with Dr. Dale Dahl in the graduate marketing seminar.

John H. Berry, candidate for the Ph.D. on temporary USDA assignment at Purdue University, has taken a position with the USDA at the University of Illinois.

Gordon E. Bivens, University of Missouri, has been elected to a second term as editor of the *Journal of Consumer Affairs*. The *Journal*, which began publication under the

editorship of Bivens, recently published its third issue. It is a publication of the Council on Consumer Information, a national organization for the study of consumer problems.

Kalman Blum, who recently completed the Ph.D. degree in agricultural economics at the University of California, Berkeley, has returned to Israel to join the faculty of the Department of Economics, University of Bar-Ilan, Ramat-Gan, this fall.

William D. Bormuth, head of the Manufactured Dairy Products Section of the Agricultural Estimates Division, Statistical Reporting Service, USDA, Washington, D.C., retired in April 19, 1968, after 34 years of commendable service—all in crop estimating work.

Emerson M. Brooks of USDA's Statistical Reporting Service, Washington, D.C., is the representative of the USDA on the four-man committee responsible for planning and implementing the joint FAO-US training program for the 1970 World Census of Agriculture.

Joe D. Brown of the Georgia Agricultural Experiment Station at Griffin was joint winner with J. C. Elrod of the annual Sears-Roebuck Foundation award for outstanding agricultural research in Georgia. The winning entry was a study entitled "Georgia Peach Producing Indus-

try: An Analysis of Interregional Competition."

George Eobert Butell has transferred from USDA's Farm Credit Administration to the Demand and Competition Section of the Europe and Soviet Union Branch, FRAD, ERS.

Ju Chun Chai, who received his Ph.D. from the University of Minnesota in 1967, will serve as leader of the AID-sponsored short course in agricultural economics research methodology at Seoul University, Suwon Korea, from May 10 to August 15.

Mollie Ann Church, formerly with the Department of Defense, has joined the Situation and Outlook Section of the Europe and Soviet Union Branch, FRAD, ERS, USDA.

David A. Clarke, Jr., on April 1, 1968, was appointed chairman of the Department of Agricultural Economics and director of the Giannini Foundation of Agricultural Economics, University of California, Berkeley.

Howard Clonts, Jr., joined the staff of the Department of Agricultural Economics and Rural Sociology, Auburn University, on March 15, 1968, as an assistant professor. He did his Ph.D. work at Virginia Polytechnic Institute.

Frank Conklin, now on the faculty at Iowa State University, will join the Department of Agricultural Economics at Oregon State University on July 1 as an assistant professor.

Robert M. Conlogue retired from the Economic Research Service, USDA, April 30, 1968, after more than 37 years of government service. During his career he worked in the Department of Labor, the Office of Price Administration, the Office of Price Stabilization, and the Minne-

apolis Field Office of the Department of Commerce. His last assignment was as agricultural economist in the Marketing Economics Division, where he did research in poultry marketing.

C. W. Crickman, field research coordinator retired from the Farm Production Economics Division, Economic Research Service, USDA, Washington, D.C., on April 30, after nearly 40 years of federal service.

Lawrence A. Dallenbach has been appointed a research associate in the Department of Economics at Iowa State University.

Charles R. Davenport, formerly chief of the Western Hemisphere Branch, Foreign Regional Analysis Division, Economic Research Service, is now director of the Operations Analysis Division, Foreign Agricultural Service, USDA.

Rollo Ehrich, associate professor of agricultural economics at the University of Wyoming, has been granted a two-year leave of absence to participate in the Texas A&M-AID program on livestock marketing in Argentina.

David E. Ellsworth has completed his M.S. at Purdue University and is pursuing the Ph.D. at Cornell University.

J. C. Elrod of the Georgia Agricultural Experiment Station at Griffin was joint winner with Joe D. Brown of the annual Sears-Roebuck Foundation award for outstanding agricultural research in Georgia. The winning entry was a study entitled "Georgia Peach Producing Industry: An Analysis of Interregional Competition."

Richard Feltner, Michigan State University, has been named assistant

dean of agriculture and director of resident instruction.

Raymond J. Folwell, who is completing his Ph.D. at the University of Missouri, is joining the faculty of the Department of Agricultural Economics at Washington State University. He will do research in the area of marketing.

Thomas F. Funk has completed his M.S. at Purdue University and is continuing for his PhD.

Bruce Lynn Gardner has accepted a position as assistant professor of economics at North Carolina State University.

David Green, Ph.D. candidate at Michigan State University, has been appointed agricultural economics specialist in the Department of Agricultural Engineering, M.S.U. He will serve as an economist on a research team studying the problems of mechanization in African agriculture.

Thomas James Grennes has accepted a position as assistant professor of economics at North Carolina State University.

Mahendra Pratap Gupta has left his position as agricultural economist in the Indian Agricultural Research Institute at New Delhi to become joint director of the Agricultural Prices Commission in the Department of Agriculture of the Government of India. He assumed his new position on February 1, 1968.

Ronald A. Gustafson has joined the staff of the Farm Production Economics Division, ERS, USDA, Washington, D.C. Mr. Gustafson is from the University of Oklahoma, where he recently completed all requirements for his M.S.

Kelly M. Harrison has been appointed assistant professor at Michigan

State University. He is serving as chief of party for the Colombian phase of the Latin American Food Marketing Project and is stationed in Cali, Colombia.

Meyer J. Harron joined the Demand Analysis Section of the Outlook and Projections Branch, Economic and Statistical Analysis Division, ERS, USDA, on March 18, 1968. He was formerly with the National Science Foundation.

Joe Havlicek, professor of agricultural economics, Purdue University, will spend the 1968-69 year on sabbatic leave for special research at the University of Chicago.

Yujiro Hayami, professor of economics at the Tokyo Metropolitan University, in Japan, will be on a two-year leave of absence as visiting associate professor at the University of Minnesota in the Department of Agricultural Economics, beginning July 1, 1968. Dr. Hayami will continue his research on the comparative effects of resource endowments, factor prices, and technical change on agricultural development. He will also share responsibility with Vernon W. Ruttan for leadership of the graduate seminar in agricultural and economic development.

Louis F. Herrmann has returned to the Economic Research Service, USDA, Washington, D.C., after two years in Brazil studying changes in agricultural output and productivity. He has been appointed to the position of staff assistant to the administrator of ERS, with responsibilities for ERS foreign activities.

Robert O. Herrmann, The Pennsylvania State University, was elected president of the Council on Consumer Information for the 1968-69 term. The council is a national or-

ganization of 1,500 members in teaching, research, and extension devoted to the encouragement and dissemination of research on consumer problems. Its activities include an annual conference and the publication of its *Newsletter* and the new *Journal of Consumer Affairs*.

Roger W. Hexem has been appointed a research associate in the Department of Economics at Iowa State University.

Roger Hill has joined the faculty of the University of Georgia at Athens as an associate professor. He will teach and do research in the area of policy. He recently completed his Ph.D. at Michigan State University.

Frederick J. Hitzhusen, who has completed the M.S. at Purdue University will be at Cornell University for his Ph.D. work.

Jack L. Hollrah, after having completed his M.S. at Purdue University and having held a temporary staff position, has now taken a position with Allied Grocers of Indianapolis, Indiana.

John M. Huie has accepted a position as assistant professor of agricultural economics, Purdue University, to work in the area of community development, upon completion of his Ph.D. at Michigan State University.

Leroy J. Hushak has accepted a position as assistant professor in the Department of Agricultural Economics and Rural Sociology at Ohio State University, effective July 1, 1968. His Ph.D. was received from the University of Chicago.

Edward L. Janzen, M.S., Kansas State University, has accepted a position in the Operations Research Department of Mead, Johnson and Co., a pharmaceutical and nutritional firm, in Evansville, Indiana.

A. D. Jones returned on June 10 to his position as assistant chief of the Fibers and Grains Branch, Marketing Economics Division, ERS, from two semesters of intensive study at the Woodrow Wilson School of Government and Foreign Affairs, University of Virginia. Dr. Jones received a Career Educational Award from the National Institute of Public Affairs.

John E. Kadlec, professor of agricultural economics, Purdue University, will spend the 1968-69 year on sabbatic leave, with special research at the University of Southern California.

John A. Kearney has completed his M.S. at Purdue University and is now in the armed services.

Earl W. Kehrberg, professor of agricultural economics, has returned to Purdue University after a two-year tour with the Purdue Project, Rural University of Minas Gerais, Vicosia, Brazil.

Richard L. Kohls, professor of agricultural economics and assistant to the vice president for academic affairs, Purdue University, has been appointed dean of agriculture, Purdue University, effective August 1968.

Gerald Korzan, professor of agricultural economics at Oregon State University, has recently resigned to take a position with the Ford Foundation in the Philippines. Dr. Korzan has 19 years of distinguished service at Oregon State.

Fonald D. Krenz, head of the North Central Field Research Group, Farm Production Economics Division, ERS, USDA, Ames, Iowa, has been appointed the Division's field research coordinator, Washington, D.C., to succeed C. W. Crickman, who retired on April 30.

Karol Krotki, formerly assistant director of research in the Census Division of the Government of Canada at Ottawa, joined the staff of the Department of Sociology, University of Alberta, on January 17, 1968.

John Layng has left the Economic and Statistical Analysis Division, ERS, USDA, to accept a position at the Bureau of Labor Statistics.

Etty Leiserson has returned to the University of Buenos Aires, Argentina, after one year with the Western Hemisphere Branch, Foreign Regional Analysis Division, ERS, USDA.

R. M. Alwyn Loyns has recently completed the Ph.D. degree in agricultural economics at the University of California, Berkeley, and joined the faculty of the Department of Agricultural Economics at the University of Manitoba on May 1, 1968.

Nicholaas Luykx, associate professor at Michigan State University, has returned to East Lansing after being on assignment in Pakistan.

Gale H. Lyon, formerly extension specialist in the USDA, has joined the Department of the Interior's Bureau of Commercial Fisheries as chief of the branch of Foreign Trade and Economic Services.

J. Patrick Madden has resigned from the President's Advisory Commission on Rural Poverty and has accepted a position as associate professor of agricultural economics at The Pennsylvania State University.

Wilbur R. Maki of Iowa State University joined the faculty of the University of Minnesota as professor in the Department of Agricultural Economics and coordinator of Resource and Community Development, Agricultural Experiment Station, on July 1, 1968.

Barbara J. McCandless, formerly research assistant in the Department of Agricultural Economics, University of Minnesota, is now associate professor of family economics, Agricultural Experiment Station, South Dakota State University, and head of the Management, Housing, and Equipment Department in the College of Home Economics.

Robert H. Miller, formerly in the Price Research Section of the Commodity Analysis Branch, has been assigned to the Tobacco Section of the Commodity Analysis Branch, Economic and Statistical Analysis Division, ERS, USDA.

Robert C. Moncure has retired from the Africa and Middle East Branch, Foreign Regional Analysis Division, ERS, USDA, and now resides in Lancaster, Virginia.

David Nelson, Ph.D., Kansas State University, has accepted a position with the Department of Agricultural Economics, University of Minnesota.

David Norman has accepted a position in the Department of Economics at Kansas State University. He will be joining the Kansas State group assigned to Ahmadu Bello University, Zaria, Nigeria, about October 1, 1968.

Stanley D. Parsons has completed his M.S. at Purdue University and has returned to the staff of the University of Rhodesia.

Thomas R. Pierson has completed his M.S. at Purdue University and is pursuing the Ph.D. at Cornell University.

Martin T. Pond, associate professor of agricultural economics, is returning to Purdue University after a three-year tour with the Purdue Project, Rural University of Minas Gerais, Vicosa, Brazil.

Raymond L. Prewett has completed his M.S. at Purdue University and has taken a position at Texas A&M University.

Malcolm J. Purvis of the Department of Agricultural Economics, Michigan State University, currently on assignment with the Consortium for the Study of Nigerian Rural Development in Nigeria, will join the faculty of the University of Minnesota as assistant professor of agricultural economics on July 1, 1968. His initial assignment will be with the University of Minnesota-AID Tunisia project.

W. P. Ranney retired on September 1, 1967, after 28 years of service in the Department of Agricultural Economics at the University of Tennessee. He is serving as visiting professor in the Department of Agricultural Industries at Southern Illinois University during the spring, summer, and fall quarters of 1968.

David Reed, Ph.D., Kansas State University, has accepted a position with Bowling Green State University.

Bruce Rettig will join the faculty at Oregon State University as an assistant professor of agricultural economics on September 1, 1968. Mr. Rettig is obtaining his Ph.D. degree from the University of Washington.

Ralph H. Rogers retired on April 30, 1968, after serving with the USDA for over 38 years. He has been located at Texas A&M University for the past 21 years.

Byron E. Sandberg has completed his M.S. at Purdue University and is now farming.

A. Allan Schmid, Michigan State University, will be on a leave of absence from September 1, 1968, to August 31, 1969, to serve as visit-

ing professor in the Systems Analysis Group, Secretary of the Army, Washington, D.C.

Andrew Schmitz joined the staff of the Department of Agricultural Economics, University of California, Berkeley, on February 1, 1968, after receiving his Ph.D. from the University of Wisconsin.

David M. Schoonover has transferred from the Foreign Agricultural Service, USDA, to the Europe and Soviet Union Branch, Foreign Regional Analysis Division, ERS. Prior to his transfer, Mr. Schoonover was assistant U.S. agricultural attaché in Moscow, USSR.

G. Edward Schuh, professor of agricultural economics, Purdue University, has accepted a six-month appointment as research associate in the Center for International Affairs, Harvard University, starting in August 1968.

Edmond E. Seay has been appointed a research associate in the Department of Economics at Iowa State University.

David W. Seckler, formerly associate professor of economics at Colorado State University, joined the staff of the Department of Agricultural Economics, University of California, Berkeley, on July 1, 1968.

Gary L. Seevers has joined the faculty of Oregon State University as an assistant professor after completing his Ph.D. at Michigan State University. He will teach and do research in the areas of policy and economic theory.

Dennis D. Sharpe has completed his M.S. at Purdue University and has taken a position at the Federal Reserve Bank in Chicago.

Lois A. Simonds, Ohio State University, was the winner of the first Award for Outstanding Dissertation Research presented by the Council on Consumer Information. The award was given for her paper, "Variations in Food Costs in Four Ohio Cities," based on her Ph.D. dissertation at Ohio State.

Richard K. Smith, director of the Agricultural Estimates Division, Statistical Reporting Service, USDA, Washington, D.C., retired on April 19, 1968, after nearly 41 years of dedicated service—all with SRS and its predecessor agencies.

Bernard F. Stanton, professor of farm management at Cornell University, has been appointed chairman of the Department of Agricultural Economics at the New York State College of Agriculture.

Daniel A. Swope, formerly director of the Division of Statistics and Economics, National Canners Association, Washington, D.C., became chief of the Food Consumption Branch, Consumer and Food Economics Research Division, ARS, USDA, on February 26, 1968. He will be located in Hyattsville, Maryland.

Richard Eugene Sylla has accepted a position as assistant professor of economics at North Carolina State University.

James M. Ward, a member of the staff of the Department of Agricultural Economics and Sociology at Texas A&M University since 1948, retired March 31, 1968. He had

long been noted for his short course in cotton classification.

Richard L. Welch has completed his M.S. at Purdue University and will be working in South America through the Brethern Volunteer Service after eight weeks of training in Maryland.

Morris D. Whitaker, candidate for Ph.D. at Purdue University, is in residence with the Fundacao Getulio Vargas in Rio de Janeiro, Brazil, doing research under a Ford Foundation grant.

Emery C. Wilcox, statistician-in-charge of the Seattle, Washington, office of SRS, USDA, received the Department's superior service award for conducting an outstanding program of public service, publications, and personnel administration in cooperative federal-state crop reporting work, contributing greatly to the agribusiness community of the State of Washington.

Joseph W. Willett has returned to the Economic Research Service, Washington, D.C., after a special three-month assignment in Indonesia with the Asian Development Bank.

Robert H. Wuhrman, formerly faculty research associate in the Department of Agricultural Economics at the University of Maryland, has returned to the Foreign Agricultural Service, USDA. Assigned to the Trade Projects Division, he is currently engaged in the administration, coordination, and evaluation of agricultural export programs and foreign market development activities.

OBITUARY

E. C. Young, formerly vice-president of Purdue University and dean of the graduate school at that institution, died on April 23, 1968, as the result of a hip fracture sustained in a fall at his home on April 17. He was 75 years old. Dr. Young had long been active in the International Association of Agricultural Economists, serving as American vice-president of the Association from 1941 to 1952. He was one of the pioneers in international agricultural development, with special interest in Latin America. He became a consultant for agriculture to the Rockefeller Foundation in 1952. He was president of the American Farm Economic Association in 1938 and was made a Fellow in 1961. He was assistant to the governor of the Farm Credit Administration during 1933 and 1934. Dr. Young's

primary interests were in research and teaching. He retained his special interests in agriculture despite the broader responsibilities that gradually came to him. Born on a dairy farm in western Pennsylvania, Dr. Young was educated at Grove City College in that state and at Cornell University. He served in the Air Corps in World War I and came to the farm management department at Purdue University in 1921. He served on the faculty of Purdue University for 42 years. Those wishing to remember Dean Young may send checks to Purdue Alumni Scholarship Foundation, Purdue Memorial Union, Purdue University, Lafayette, Indiana 47907, with envelope marked *Dean Young Fund*. Mrs. Young is living at R.R. 9, Lafayette, Indiana.

ORGANIZATIONAL

A Conference on Regional Water Resources Research was concluded at Chicago, Illinois, on March 26-27, 1968. The conference grew out of a recommendation of the North Central Region Agricultural Marketing and Economics Advisory Committee (NCA-12) that a review of water resource economics research in the North Central area be undertaken for the purpose of evaluating current projects and planning future programs. Attendance included various Economic Research Service personnel in the region, state agricultural experiment station leaders in water resource economics, and directors of state water resource institutes established under Public Law 88-379, the Water Resources Research Act. The institute pro-

gram is administered by the Office of Water Resources Research in the Department of the Interior. Dr. R. R. Renne, Director of OWRR, reviewed Interior's water research program and critiqued a background paper on the status of Hatch Act regional water research in the North Central States that was prepared jointly by Dr. Gordon D. Rose of South Dakota State University and Dean T. Massey of the Economic Research Service. Mr. Massey is stationed at Madison, Wisconsin, and serves as coordinator of a current regional water research project (NC-57) on legal and economic factors in managing water resources in agriculture. Dr. Rose is a former employee of ERS and is now extension economist in

public policy at South Dakota State. Other major papers were given by Emery N. Castle of Oregon State University; George M. Browning, regional director, North Central Agricultural Experiment Station Directors; John F. Timmons of Iowa State University; A. Allan Schmid of Michigan State University; Wilbur R. Maki of Iowa State University; and Paul L. Holm of the Economic Research Service, Washington, D.C.

Kansas State University has announced two new research projects which have been undertaken in the Department of Economics. The first is a research effort using the systems analysis approach to study market quality of wheat, which has been initiated under the supervision of Professor Leonard W. Schruben. The project is to be conducted under the joint sponsorship of the Economic Research Service, USDA, and the Food and Feed Grain Institute of the Kansas Agricultural Experiment Station. The program is long range in nature, with an estimated annual expenditure of \$100,000, with \$31,000 from the Economic Research Service for the current year. Professor Schruben, who is also associate director of the Food and Feed Grain Institute, is currently on sabbatical leave serving as a visiting professor at Stanford University, and will be returning to Kansas State University in June. The second is a research project to develop economic projections for Kansas industries and regions. The U. S. Bureau of Reclamation is financing the project through a \$42,300 contract. Dr. M. Jarvin Emerson will direct the research effort, which will extend over an 18-month period. The project will utilize the Kansas

input-output matrix which is being completed by the staff of the Office of Economic Analysis under Dr. Emerson's direction. The results of the study are expected to provide a basis for future water use projections.

The Latin American Market Planning Center at Michigan State University has received a supplemental grant of \$260,000 from US/AID. This will support a research and advisory program on market development in Colombia, South America. The program is being allocated an additional \$150,000 by the government of Colombia. Dr. Harold Riley, professor of agricultural economics, and Dr. Donald Taylor, professor of marketing, are directing the LAMP project, which previously operated in Puerto Rico, Northeast Brazil, and Bolivia. Dr. Kelly Harrison, assistant professor of agricultural economics, will be chief of party for the Colombian operation. Working relationships have been established with the University of Valle in Cali.

Oregon State University was one of three institutions receiving institutional grants under the new Sea Grant Program administered by the National Science Foundation. Other universities so designated were the University of Washington and the University of Rhode Island. Under this program the Department of Agricultural Economics at Oregon State University has been given responsibility for developing and conducting a research and training program in marine economics. This work will complement existing agricultural economics and resource economics programs in the department.

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The Supply of Speculative Services in Wheat, Corn, and Soybeans	Lester G. Telser
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On Scientific Objectivity*

EMERY N. CASTLE

The research process is never devoid of value judgments. Nevertheless, motivation of the researcher does not necessarily render work unobjective in a scientific sense. Threats to scientific objectivity include the difficulty of changing a publicly expressed viewpoint, a vested interest in a particular theory, the desire to avoid controversy, and the desire for financial gain. The researcher must be careful, however, to avoid equating his own views with the "public interest" and condemning those with opposing views as lacking scientific objectivity.

SCIENTIFIC objectivity may be defined in a rigorous fashion consistent with any particular philosophy of science. According to Popper [9], scientific objectivity consists of the freedom and responsibility of the researcher (1) to pose refutable hypotheses, (2) to test these hypotheses with relevant evidence, and (3) to state the results in an unambiguous fashion accessible to any interested person. If these requirements are met, scientists can replicate one another's work and expect to come to the same conclusions.¹ The method is an impersonal one. When Popper's three requirements are met, there need not be great concern about the motivation of the researcher. If a researcher fails to meet the requirements of the method, he will sooner or later be found out.

Any reasonable person, however, recognizes that these conditions are not present in much of the work done by agricultural economists. By and large, much of their work does not involve the testing of refutable hypotheses. The reasons for this fact are properly the subject of another article; nevertheless, it should be noted that scientific objectivity is capable, at least in principle, of rigorous definition and can be subjected to rigorous test. When the strict requirements for a "science" are not present, the matter obviously becomes more subjective. Even so, the limiting case is useful as a norm against which we can test most activities of agricultural economists. The more "scientific" a field, the more automatic objectivity becomes. There is comfort in this truth, because it is known that some scientists will lie, threaten, and steal to promote a particular point of view or to add to or protect their scientific reputations. Nonscientists guard

* Oregon Agr. Exp. Sta. Tech. Paper 2512. The following individuals contributed substantially to the content of this article: Richard S. Johnston, T. W. Schultz, James Youde, and Joe B. Stevens. Of course, they are in no way responsible for the conclusions reached.

¹ A story exists about the late Albert Einstein, who, when told, "Professor Einstein, more than 200 books have been written refuting your special theory of relativity," replied, "One would have been enough."

against these human frailties through group action; scientists rely upon replication and refutability. Human experience in both scientific and non-scientific communities indicates that individual altruism is a shaky foundation on which to base objectivity. Some mechanism is needed to mesh individual and group interests.

Threats to Objectivity

If we tentatively assume that (1) objectivity is in the public interest, and (2) short-run individual self-interest of the researcher is not always enhanced by objectivity, it then becomes important to examine the conditions that may give rise to a lack of correspondence between the two. Our list is not an exhaustive one; it does establish that threats to objectivity can come from many sources.

Desire for approval

The researcher may be more interested in approval at a point in time than he is in advancing the subject matter knowledge of his field. This does not necessarily mean that he is unable or unfit to add to knowledge. It simply means that he needs to know that his compromises may be found out. The form of these compromises will be dependent upon the type of approval he seeks. They may take the form of unwillingness to reveal findings, failure to consider relevant observations, or ambiguous refutability standards. This category is not mutually exclusive of those that follow.

Advocacy of a particular public policy

A scientist may formulate and advocate a position on a particular public policy at a point in time based on all relevant scientific knowledge to that time. Because of the difficulty associated with changing positions in public view, he may not be willing to consider subsequent relevant observations that bear on the matter. This is not to argue that scientists or researchers should not become public advocates but simply to recognize the risks. Our profession is obviously becoming much more sophisticated on this point.

Vested interest in a particular theory, hypothesis, or approach

The difference between this case and the one above is that the researcher may need to change positions in view of his colleagues rather than the general public. Chamberlin recognized this danger several decades ago. In a classic article [2] he advocated the use of multiple working hypotheses as a way of avoiding a protective attitude toward a particular hypothesis.

Desire to avoid controversial problems

Most scientists wish to see their projects and organizations survive and grow. A temptation exists to avoid those research problems or research results that may endanger the researcher's project or organization. Effective ways of dealing with these pressures are not as frequently discussed as they should be.² Choice of projects is not always under the control of the individual researcher, but once he embarks on a problem, he has the responsibility of insisting on freedom to apply the conditions of refutability and relevance. If this freedom does not exist, he has the responsibility of making "a helluva fuss." The administrator, however, cannot get off the hook so easily on choice of projects. We believe that controversy will follow relevance but that the two do not have perfect positive correlation.³

Desire for personal financial gain

Researchers have become useful people and are in demand in both the private and the public sectors. If a person is hired to rationalize, defend, or advocate a policy viewpoint, it is obvious that he is not engaging in research, and objectivity considerations hardly seem relevant. The principal difference between public and private units in this context relates to the beneficiaries involved.⁴

Why do we question a researcher's objectivity more if he is working in the private sector than if he is working in the public sector, or more if he is being paid a handsome fee than if he is doing the work for free? As a researcher he will be of greater value to his employer if he gives "correct" scientific answers than if he gives "incorrect" answers. To argue that scientific objectivity criteria are being violated because the objectives of the private firm may not be in the public interest is to place on the shoulders of the researcher responsibility for external diseconomies that stem from causes quite independent of the researcher's activity. Regardless of

² There are the famous controversial cases, resulting in widespread publicity, which *are* discussed, but accurate records and accounts are often missing. There are undoubtedly many quiet battles being fought daily which require great courage but about which we hear little. My personal experience is that early, frank discussion of professional responsibility can often eliminate difficulty later in the research process. The professional must be willing to fight in the public arena, but this is not his only battleground.

³ For a definition of the word *relevance*, see Hildreth and Castle [6]. This article is not a definitive treatment; more thought needs to be given to the subject. See also Herendeen [5], Kaldor [7], and Schultz [11]. To be sure, "relevance" is not primarily an objectivity issue.

⁴ Many physical and biological scientists, with excellent reputations both as scientists and as administrators, frequently ask economists to "justify" a particular innovation or new technology. Upon explanation, some, but not all, are able to grasp the distinction between "justification" and "evaluation." We do them and ourselves little service if we let ourselves be used in this way.

how much we abhor the thought of the highly qualified chemist's using his talents to differentiate a toothpaste from that of a competitor, the problem is not one of scientific objectivity. To address the problem in these terms diverts attention from the real issues.

Economics and Objectivity

To address the subject of this section squarely, I treat the use of economics as an art. When the economist gives practical advice to the firm or to policy makers, he is not primarily engaged in the process of formulating and testing hypotheses [4]. Whether one calls this "art" or "applied science" or "service research" does not appear fundamental. I distinguish it from the "method of reflective inquiry" as a means of advancing knowledge [3, p. 195; 8; 10, Chap. 7].⁵

When economics is made "useful," the question arises as to whose use will be recognized. This recognition comes through choice of projects, professional position, and peer group. These choices reflect individual values, goals, and objectives and are controlling with respect to the individual's use of his talents. In this context, the following types of questions need to be faced. Do we wish to maximize our personal income? If so, what is the relation of this desire to serving others in society? If we serve a private firm, what is the relation of this activity to the "public good"? Do we wish to work within the power structure of our society or to do work which will result in the change of that power structure? These crucial normative questions demand greater discussion. We will do well to ponder the difficulty of making interpersonal utility comparisons in a scientific sense before coming to the conclusion that a particular decision will automatically preclude or insure scientific objectivity henceforth.⁶ Once these kinds of questions are recognized for what they are, considerations of objectivity assume their rightful importance. The scientist must constantly ask himself: (1) Am I free to pose refutable hypotheses and examine relevant evidence? and (2) Do I apply these standards and make the results known? The temptation to tell clients what they want to hear is not unique to the economist serving the private sector.

As far as economics is concerned, it appears that considerable intellectual effort might be devoted to the following questions:

1. Is economics a discipline that makes scientific inquiry possible? Is it possible to construct refutable hypotheses, given the kinds of empirical

⁵ This is not to deny that knowledge can be advanced through "applied" research. I make the distinction only to get at the issue of motivation.

⁶ We should guard against the superficial assumption that we know what is in the "public interest" and must therefore condemn as lacking objectivity any work that does not further this interest. The "public interest" can be defined only by value judgments, and a researcher who has other interests is not necessarily lacking in objectivity.

observations that it is possible to make? If not, why not and what would be required to make it so?

2. What are the principal normative questions facing us individually and collectively as a profession? If the practice of our art requires rules or standards for the protection of economists, or the public generally, they should be formulated. But some should be recognized for what they are—a substitute for the self-correcting nature of the process of science.

The issues discussed here were raised by Breimyer in a recent issue of this journal [1]. They are of tremendous importance. To be sure, I believe that another approach to the questions which he asks is likely to be more fruitful than his, but this difference is beside the point. What is important is that we have discussion and debate on the questions that he poses and on those suggested here. The intent of this article is to clarify some of the methodological and normative issues involved in this discussion.

Agricultural economics has passed through a period of preoccupation with quantitative tools and results. We now are entering a phase of intensive involvement with the burning issues of education, poverty, hunger, and growth. In a sense, we are witnessing a return to the original motivation of our profession. I am both thrilled by and proud of these trends. However, we must be rather careful to avoid the too-quick use of the term "scientific objectivity." Careless use of the term could result in the lack of freedom to dissent from "conventional wisdom."⁷ If we say that all those who are not working to promote the "public interest" suffer from a lack of objectivity, we obscure the distinction between the normative and the positive at a time when even greater clarity regarding this distinction is needed.

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Reflections on the Organization of Regional Research Activities*

MARSHALL HARRIS AND R. J. HILDRETH

Regional research in economics under the Research and Marketing Act of 1946 is at a crossroad. If certain organizational problems are not resolved, commitments by administrators and researchers to regional research will continue to decline. The habits of thought of administrators, inherent weaknesses in the committee setup, and experience with focusing research on state and local problems made it easy to plan and conduct "regional" research with little regard to regional problems and team effort. Regional research should extend a warm welcome under an inspiring environment to well-qualified researchers. Suggestions for improvement of regional research include: (1) experimentation with programs of regional research in contrast to a series of narrowly defined, uncoordinated, short-term projects; (2) the appointment in some cases of regional coordinators to effectuate the policies and plans of regional committees; (3) the establishment of regional research centers with small staffs for certain types of projects; and (4) more flexibility in size and composition of regional committees.

THE Research and Marketing Act of 1946 [6, pp. 1082-91] made feasible for the first time a comprehensive program of regional research on problems that concern the agriculture of more than one state. The Congress was guided by the experience of regional groups and the long history of federal-state cooperative research. Two decades have passed since enactment of the legislation. It seems appropriate that selected aspects of regional research under the act be evaluated at this time.

A central concern is this: If problems facing the organization of regional research activities are not resolved, commitment by researchers and administrators to regional research will continue to decline. Regional committees might continue to meet to discuss mutual problems, but regional research in agricultural economics could largely disappear.

Our evaluation of the organization of regional research will treat (1) the foundations on which regional research was established, (2) the nature of regional economic problems and research, (3) criteria to guide the evaluation, (4) obstacles and problems in regional research, and (5) possible lines of improvement. The evaluation will be concerned only with research in agricultural economics, although the problems and principles

* This article is the outgrowth of discussions of the Interregional Land Economics Research Committee. Opinions and statements of the authors do not necessarily reflect the policies of the U. S. Department of Agriculture, Cooperative State Research Service, or the Economic Research Service. The discussion is confined to regional research in agricultural economics as provided for in the Research and Marketing Act of 1946, as amended, usually designated as RRF research.

MARSHALL HARRIS is an agricultural economist with the Economic Research Service, USDA, and R. J. HILDRETH is associate managing director of the Farm Foundation.

may be the same for other disciplines. Though the perspective is that of researchers, it is not intended to be narrowly so.

Background for Present Analysis

Historical bases [1]

Anyone associated with a popular idea tends to feel that it is new and to lay claim to it by virtue of having paid the price of time and toil and tears in its conception and development. So it is with regional research. Yet it is difficult to discover from the records when the idea of regional research emerged and who fathered it. Within a few years after the state experiment station law was enacted in 1887, the advantages of cooperative regional research were recognized. It was suggested that (1) the states should cooperate in studying problems of common interest, (2) the USDA should assist as circumstances indicated, and (3) the states should reciprocate.

In 1913 southern livestock researchers began meeting regularly, and with the establishment of the New England Research Council on Marketing and Food Supply in 1922 regional research made another leap forward. By 1925 the merits of regional research were discussed widely, and special subject-matter research committees were established. Regional research received only minor attention during the lean years for agriculture between 1925 and 1935. The Bankhead-Jones Act of 1935 [5, pp. 436-439] provided for regional laboratories, and four years later the Farm Foundation initiated its system of regional research committees. The experience with these activities was cited in securing passage of the Research and Marketing Act of 1946.

Progress and testing

Upon passage of the Research and Marketing Act of 1946, preference was accorded research suggested by already established regional committees and narrowly defined line projects. During the early days, definitions and concepts were formulated, working relations among participants were formalized, and interdisciplinary research was explored. Regional research expanded rapidly and became an integral part of agricultural economics research.

Coordination of regional research projects in economics has varied widely. It has ranged from a minimum of coordination, with the content of contributing projects turning largely on the interest of the individual researchers, to a high level of coordination with region-wide, uniform questionnaires and methods [3, p. 882]. Many regional projects have become large umbrellas which allow individual states almost unbridled liberty.

The real crux of the matter may be the conflict between a regional proj-

ect concerned chiefly with a regional problem and contributing projects concerned with state problems. The contributing project idea possibly has been corrupted until it has lost its original intent and has resulted in a loose confederation of remotely related investigations rather than tightly integrated regional analyses.

Regional research has not become prestigious. Increasing numbers of researchers eschew all association with it, especially promising young researchers who want to make rapid professional progress.

In our zeal for improvement of regional research, it is easy to overstate its weaknesses and overlook its many valuable contributions and accomplishments. Such is not intended. Participants in regional research are fully aware of the overall effectiveness of technical committee discussions on the many research activities in agricultural economics and of the excellent results of several well-coordinated regional projects.

Rationale

The objectives of regional research are contained in the *Manual of Procedures for Cooperative Regional Research* [4, p. 2]. They include (1) stimulating and facilitating interstate cooperation on research of a regional and national character, (2) planning and coordinating research to avoid duplication in research effort, and (3) organizing regional technical committees to plan and coordinate work on regional and national problems.

Regional research is a means for studying specific and important problems which require integration and analysis of data from two or more states and which are not likely to be solved by the individual states or the USDA or through existing federal-state projects. It offers an opportunity to obtain better evidence for testing hypotheses than generally would be feasible under individual state or federal efforts. It facilitates bringing together competencies, equipment, and other resources not generally available at any one station.

Regional research can facilitate the introduction of new concepts and research methods through committee discussion and action. It affords an opportunity for specialization and for capitalizing on the special insights of each researcher. It provides favorable conditions for integrating the separate brain power of the researchers into a super-brain or a group mind for an organized attack on larger problems than could be studied otherwise.

Nature of Regional Problems and Research

The *Manual of Procedures* states that regional research is to be distinguished from other types of research by two characteristics: (1) the research must focus on a specific and important problem of concern to two

or more states, which can be attacked more effectively by a regional approach than by individual stations working independently along the same lines, and (2) the research must be planned and conducted as a concerted team effort in which the participating scientists are mutually responsible for accomplishing the objectives. The *Manual* goes on to state that the problem selected for research must be truly regional in nature [4, p. 2].

Sufficient conditions for regional research are contained in the ideas "of concern to two or more states" and "can be attacked more effectively by a regional approach." "Team effort" could be used effectively on intra-state problems and thus may be viewed as a necessary but not sufficient condition for regional research.

A key element in any problem of concern to two or more states is interdependence of the economic consequences of public or private policy and action. For example, major agricultural policy usually deals with national or regional problems because the decisions on policy usually do not depend upon the voters of one state but of the nation or region. Even specific commodity policy usually involves consequences for the producers in more than one state. Natural resource development also often involves consequences for firms and households in more than one state.

A regional problem may be said to exist where the situation in two or more states is similar and the problem can be attacked more effectively on a regional basis than by individual stations. For example, landlord-tenant relations are similar within the Great Plains, the Corn Belt, or the irrigated West. Because the problems are similar a regional approach will often lead to more imaginative and useful research than an individual state approach, and it will also reduce unneeded duplication. In this case, the definition of a regional problem turns largely on the usefulness of joint research and action as compared with independent efforts.

Criteria for Evaluation

Some of the criteria for assessing regional research may be unique to regional research; other criteria may be applicable to nonregional research as well.¹ The following eight criteria will be used to guide the appraisal here:

1. The problem should be regional, that is, it should require a regional attack.
2. The problem should be susceptible to explicit definition—to being set apart from other problems to obtain definition and specificity.
3. It should rank high in importance among existing problems.

¹ These criteria are not designed to distinguish regional from nonregional research—that distinction has been made already.

4. Regional analysis should provide economies of scale and specialization that cannot be attained under independent state research.
5. The research should provide an environment conducive to high attainment and be increasingly satisfactory to researchers.
6. It should encourage each researcher to be committed to the particular problem under analysis.
7. Each contributing project should make direct and specific contributions to the regional analysis, thus providing for reporting on a regional basis.
8. Each regional research project should provide for a wide exchange of research methods and methodology.

Obstacles and Problems²

Regional research in agricultural economics has not been all that its sponsors and supporters anticipated. Economic research had been focused on state and local problems for over half a century before the 1946 Act was passed. The habits of thought of most administrators and researchers had taken a form that reflected almost exclusively a state and local viewpoint. Added to this situation was the cult of academic freedom. With the introduction of regional research, we failed to modify sufficiently the existing structure to permit effective research and action on regional problems. Regional research has been superimposed on a federal-state cooperative system designed to accommodate state and local problems. Often contributing projects under regional research are planned and conducted with little regard for the regional study and with little or no team effort, except exposure to general discussion at committee meetings.

Committee system

Many of the obstacles to successful regional research are in one way or another complications associated with committee operation. The committee system has meant usually that representatives from 12 to 14 states are brought together to plan and carry out the regional project. Such committees are too large for most research. Also, each state appoints its own representative, often without considering the committee's needs. These circumstances almost inevitably have the result that much of the work load of regional research projects is carried by a few of the most competent, who frequently do not receive adequate recognition, while others do not contribute their fair share.

The present regional procedure contains an anachronism that forces researchers into ineffective planning of research. The *Manual* provides that

² The many accomplishments of regional research and how they were attained are not discussed here.

the project must be completely planned, ready to go, and formally approved before regional research funds are allocated to it. This often means hasty, inadequate planning under unfavorable circumstances.

Administrative matters

The problems of administrative approval that exist in state and federal research also exist in regional research. The necessity for regional clearance, when added to the need for state and federal approval, dissipates the energy of researchers, at times almost to the point of despair. Remoteness of clearance officers from the researchers too frequently leaves the latter feeling that they are hunting crows in the dark.

The key decision makers according to the *Manual* are the Committee of Nine³ and the Cooperative State Research Service (CSRS), who have legal responsibility for the program as it now operates; the four regional associations of directors, who evaluate each regional research proposal; the administrative adviser for each regional committee, who serves in a liaison capacity to the technical committees and represents his regional association of directors; and the technical committees of researchers, who plan and execute the regional research and who are responsible directly and completely through established administrative channels.

Some experiment station directors have found the administration of regional research complex and time-consuming. Some CSRS personnel associated with regional research have expressed similar views. The administrative adviser and the CSRS representative can contribute most to the regional research activity if they have considerable competence in the same disciplines, in broad terms, as the technical committee. They can then be concerned as much with intellectual leadership as with administrative minutiae.

Many technical committee members feel that the amount of paper work is excessive. Many of the revisions of project statements and the required annual reports are felt to be unproductive work. Researchers also are concerned about the time and effort required to obtain approval and publication of the reports resulting from regional research.

The uncertainty about level of support for contributing projects is another obstacle to effective regional research. The technical committee is never quite certain how much manpower and funds will be allocated to the regional study via each contributing project. Technical committees have been reluctant to ask administrative advisers to intervene when some contributing project is not meeting expectations. The procedure provided

³ The Committee of Nine is a statutory committee of the USDA, elected by and representing the directors of the state experiment stations, whose duty it is to recommend cooperative regional projects for approval by the Secretary of Agriculture.

in the *Manual* for negotiation does not seem a viable option to members of some technical committees [4, p. 5].

Problem selection and definition

Problem selection and definition in regional research is a complex process. Because of the number of viewpoints to be accommodated and minds to be satisfied, the problem statement is too frequently written to encompass all of the research that all of the researchers want to do rather than to make contributing projects actually contribute to the analysis of a specific, well-defined regional problem. Or problem statements are designed to meet what is thought to be the directors' and CSRS's expectations in order to obtain approval.

When many committee members are involved, often all that emerges is generalized notions about the problems. Generalized notions usually are of little use in formulating hypotheses, outlining evidence needed to test them, and selecting the analytical process. The study is likely to tend toward descriptive-panoramic research rather than analytical-explanatory research.

Too often, regional research is not undertaken until the problem is in full bloom. The almost intuitive sensing of crucial regional problems as they emerge is essential because of the slowness of obtaining results and of translating these results into effective action. The interchange of ideas by persons interested in regional research should facilitate an early definition of emerging problems.

Additional consideration should be given to interregional problems and research. Such research is provided for but very little has been undertaken [4, pp. 16-19].

Appropriate techniques

The committee's selection of research methods is fraught with difficulties similar to those of problem selection. Although the committee procedure for research offers many opportunities for bringing to light new and useful research techniques, one of the problems is to convince all members of the committee of the value of such techniques. Often the net result is the selection of a "least common denominator" method rather than a new, bold, and exciting procedure. Some regional research projects have solved these problems, but many have used innocuous, out-of-date, well-worn methods.

Implementation of research

The question of implementation follows full agreement on and commitment to the problem and the methods. The balancing of a sizable re-

search problem against the availability of scattered personnel and an unknown budget is complicated. The output of the research depends upon each member of the team fulfilling his part of the agreement on schedule. Effective implementation of a regional project demands closer integration of the contributing projects than has often occurred. Data collected on uncoordinated schedules, coded in different classifications, compiled by different processes, and analyzed by different statistical techniques cannot be combined in a manner to permit analysis of the regional problem.

Presentation of results

In the past, too many regional researchers have been concerned largely with writing journal articles for their colleagues and preparing technical publications for use by top leadership. Too few have worked with those responsible for continuing education in adapting technical research results to the needs of nontechnicians.

The results of regional research too frequently have been interpreted by each state on its own. Only a few of those involved in regional research have worked with regional and national groups in interpreting and utilizing the research. Still fewer have worked with legislative groups in considering the implications of their research. Seldom do researchers work with regional groups in adapting the results of research for wide general use.

Some Suggestions

We make no endeavor to offer new or novel suggestions. Possibly most of our suggestions have been considered at one time or another. The difficulties inherent in the committee system, the general attitude toward work on regional committees, the rapid turnover of personnel in the region, and similar problems do not permit a single prescription.

There is no suggestion that some other organizational structure should be substituted for the committee system. However, those who operate it should be conscious of its limitations and should strive to capitalize on its strengths and minimize its weaknesses.

Individual researchers

Regional research should extend a warm welcome in an inspiring environment to well-qualified researchers. Otherwise, it will fail to elicit the commitment necessary to maintain an effective program of regional cooperation. It is suggested that the CSRS prepare periodic analytical and evaluative reports on the status of regional research and make such reports suitable to the needs of and available to individual researchers on all regional research projects. Some of the unresolved problems of planning, coordinating, and implementing regional research grow out of re-

searchers' lack of knowledge of the philosophy, objectives, and procedures of regional research, and past experience with it. Such information would help familiarize researchers with the philosophy and objectives of regional research and its current status. Without a solid foundation and full comprehension of the unique role of regional research, the individual researcher is in a poor position to maximize his contribution as a member of a technical committee and as a proposer of contributing projects.

Adjustments in the regional research program should extend and improve opportunities for the intellectual development of researchers. Ways and means should be found to encourage the use of regional research funds to expedite development of intellectual resources for attacking regional problems. A major contribution of regional research has been the stimulation that results from the opportunity of station and USDA personnel to meet and discuss research problems of mutual interest. Regional committees sponsored by the Farm Foundation provide one means for intellectual development of agricultural economists in several broad areas. These programs, however, do not provide for sufficient integration among the broad areas of agricultural economics to produce adequate solutions to the emerging problems of agricultural and rural areas.

Programs of regional research

To overcome some of the shortcomings of regional research, it is suggested that one or more regions experiment with one or more programs of economic research in contrast to a series of narrowly defined, uncoordinated, short-term projects. A program of research would mean a long-term commitment to a problem area. It would lay out an area of study within which specific, narrowly defined projects, each a part of the program of research, could be formulated and completed on a coordinated time schedule. Regional research legislation permits the development of such programs of regional research; it does not require short-term regional projects. The major evaluation of a program of research largely turns on continuity versus opportunism—a suitable planning horizon for researchers versus the opportunity to shift from one problem to another, perhaps without doing enough research on either to be effectual. A program of research that would permit longer-term planning might not fit all regional research. Some research might best be planned and conducted on a short-term basis.

A program of research in many cases would facilitate the commitment of state personnel to the cooperative undertaking and would encourage the planning of some of the nonregional research of the participants to complement and supplement the regional research. A program of research would make it unnecessary to force regional research ideas to fit the current research program in each cooperating state.

Also, a program of research would reduce the stress and strain of frequent project approval and other time-consuming paper work. A program of research might afford a more certain level of support for the program from year to year. In addition, the more stable environment would doubtless present an improved opportunity for building higher commitment among those associated with regional research.

Regional coordinator

It is suggested that certain regional committees (but not all) need an executive—a regional coordinator. Committee members in some cases may be permitted to play the role of a board of directors [2, p. 892]. The regional coordinator would be given power and funds to effectuate the committee's policies and plans. Perhaps the responsibilities and authority of past regional coordinators have not been specified in sufficient detail in regional project statements, and their role may not have been fully accepted by the researchers and the administrative hierarchy.

Regional research cannot be the product of a committee of a dozen or more researchers, except through the role of such a committee as a board of directors. Essential coordination and integration cannot be attained through one or two committee meetings a year. Constant effort at all stages of the research is necessary to make the individual state projects contribute to solution of the regional problem.

One of the unsolved problems of regional research is obtaining the services of a qualified regional coordinator. An assignment as coordinator is not coveted by researchers and is usually accepted with little enthusiasm. The reasons are not hard to find. Most tenured researchers are reluctant to break their chain of employment to accept full-time work as regional coordinators. Many young nontenured researchers have not had sufficient research experience to fill the role of coordinator.

There are several other reasons why it is difficult to employ a regional coordinator. Young researchers feel that they must build an acceptable research image as quickly as possible to survive in this highly competitive intellectual environment. Established researchers are reluctant to spend much time on research that does not fit their portfolios. They are usually averse also to spending much time preparing regional reports because of the difficulty of identifying contributions and the limited credit usually accorded.

Employment of coordinators by CSRS is an option that might be considered. Under unusual circumstances an economist nearing retirement might serve well as a regional coordinator. Another possibility is to have a senior researcher serve as coordinator, supported by a small regional project staff. The coordinator would be more effective in a program of research than on a single, short-term project.

also discussed in the ordinary theory of competition (e.g., excess capacity) or are hypotheses. . . . The main pedagogical contribution of the doctrine of workable competition [merely has been to emphasize that] monopolistic competition theory, by putting all industries under one label, fails to recognize quantitatively important differences in monopoly power, and thus provides no guide to policy" [67, p. 504].

My purpose in this article is to contribute to the development of what Stigler called "a list of meaningful and manageable criteria." I first discuss principles that I think a writer should follow if he wants to present a concrete concept of effective competition. I then list the criteria that I regard as appropriate—25 of them.

Principles to Follow in Defining Effective Competition

In presenting his concept of effective competition, a writer can clarify his meaning and increase the usefulness of his work by following certain principles. He should be specific, definite, explicit, realistic, discriminating, comprehensive, and stringent.

Be specific

A writer should enumerate the variables whose states determine whether a market is, by his standards, effectively competitive. In other words, he should list the issues that he thinks need attention.

If a writer is not, in this sense, specific, he will do little more than rephrase the question. Consider, for example, Markham's proposal: "An industry may be judged to be workably competitive when, after the structural characteristics of its market and the dynamic forces that shaped them have been thoroughly examined, there is no clearly indicated change that can be effected through public policy measures that would result in greater social gains than social losses" [41, p. 361]. In judging the U.S. rayon market, Markham considered, among other factors, price leadership, price flexibility, economies of scale, the number of sellers, the

[15]. More recently, Clark switched to a label that L. H. Wallace selected, also in 1940, namely, *effective competition* [75, p. 69]. Clark explained, "I am shifting . . . from 'workable' to 'effective competition' . . . because 'workable' stresses mere feasibility. . . . Some departures from pure and perfect competition are not only inseparable from progress, but necessary to it" [14, p. ix].

² Peterson views current discussions of effective competition as a natural outgrowth of classical economic thought. Writing in the *American Economic Review*, he said, "The views to be corrected now by theories of a 'new' competition that is 'workable,' [are not those of Marshall, Pigou, or J. B. Clark, but] rather those of followers of Chamberlin who fell into the bad habit of equating competition with pure competition, of confusing theoretical benchmarks with policy norms, of expecting highly monopolistic behavior in most markets where competitors are few" [53, p. 76]. No such charge, I should add, can fairly be made against Chamberlin himself [12, Chap. 5].

specifying extenuating circumstances. That is, he can refer, not to individual market characteristics that he often would approve or disapprove, but to *combinations* of market characteristics that he invariably would approve or disapprove.³ To anticipate and specify extenuating circumstances, admittedly, is difficult. Whether the task is feasible is not yet clear.

Be explicit

A writer should distinguish between conditions that are necessary and conditions that are sufficient for a market to be, by his standards, effectively competitive. In other words, he should indicate whether the conditions that he is approving are required or merely will suffice.

If a writer is not, in this sense, explicit, it will be difficult for others to know what he means. Meriam, for example, expresses disapproval of price leadership, of stability of market shares, of arrangements that protect the inefficient or prevent entry, of technological inertia, and of parallelism in innovation [45]. It is not clear, however, which of these deficiencies, if any, *must* be absent in order for a market to be effectively competitive by Meriam's standards.⁴

Be realistic

A writer should restrict his necessary conditions of effective competition to those that he believes every market can achieve, that is, to those whose absence in any market, he thinks, either could now be rectified or could previously have been avoided by an appropriate change in personnel, organization, or public policy. As J. M. Clark once expressed it, one should not demand more than what unavoidable circumstances will permit.

If a writer is not, in this sense, realistic, the therapeutic value of his concept will be reduced. Edwards, for example, asserted that "there must be an appreciable number of sources of supply" [23, p. 9]. If *appreciable* means more than one, this condition is not attainable when products are first introduced or when indivisibilities and scale economies are large relative to demand—as is true, for instance, of many services that are sold to residents of small towns. As a result, no policy implications would follow if it were found that the states of various markets are not, by Edwards' standards, effectively competitive; it would not follow that something could be done to rectify the situation, or even that something could have

³ Another way out is for a writer to specify only sufficient, not necessary, conditions of effective competition.

⁴ In contrast, it clarified Mason's position when he said, "The fact that large numbers of buyers and sellers *will* ensure workable competition does not mean, however, that such numbers are necessary" [43, p. 179].

been done in the past. Instead of inviting a search for remedies, the finding invites bemoaning cruel fate. Furthermore, an unrealistic concept cannot serve as an objective for public policy without, like perfect competition, introducing debilitating problems of the second best. By *problems of the second best* I mean the complications that arise if we try to rank positions, none of which we regard as best.

These complications have been analyzed by Lancaster and Lipsey [35] in terms of constrained Pareto optima. Ferguson has pointed out that Clark's initial discussion of workable competition [15] to some extent anticipated Lancaster and Lipsey's conclusions. Ferguson provides a clear exposition of the general theorem of second best:

The general theorem of second best states that if an irremovable constraint is introduced into a general equilibrium model so as to prevent the attainment of one or more of the Pareto optimum conditions, the remaining Pareto conditions, although still attainable, are not necessarily desirable. . . . Two important corollaries follow immediately. In the first place, there is no *a priori* way to evaluate different situations in which some, but not all, of the Pareto conditions are fulfilled. . . . Countervailing imperfections can be found only by detailed, and frequently complicated, analysis. In particular, it is *not true* that a situation in which more, but not all, of the optimum conditions are satisfied is necessarily, or even likely to be, superior to a situation in which fewer are realized. . . . J. M. Clark was the first economist clearly to state this corollary and to search for countervailing imperfections. Second, there is no *a priori* way to evaluate different situations in which none of the Pareto conditions is met. As a particular application, it is not necessarily true that a situation in which all deviations from the optimum conditions are in the same direction and of the same magnitude is superior to one in which the direction and magnitude of deviations vary [for example, one] in which the degree of monopoly varies among industries [26, p. 15].

According to Ferguson, problems of the second best make it futile to seek a microeconomic concept of effective competition. "One may," he wrote, "find individual firms that do not have . . . prescribed imperfections but do deviate from 'perfection' in . . . ways considered desirable. There may be a temptation to call these firms 'workable' competitors. It should be resisted, however, for if any other firm were to change the degree of its imperfections, there might immediately be corresponding changes in the firms under consideration. For this reason one can only define a workably competitive economic system" [26, p. 80]. But Ferguson's conclusion is, I think, too strong. In deciding what we want in individual markets, we should be careful. With respect to an industry's costs, for example, we should not assume that input prices invariably equal social opportunity costs. With respect to the level of output, we should not demand that

price equal marginal cost except where marginal cost is zero. With respect to joint action, we should not make the grounds for objecting to collusion be that it elevates prices above marginal costs.

Being realistic implies acknowledging factors such as indivisibilities and recognizing that, as Bain put it, "in an uncertain world some divergences may result from accident rather than from design" [4, p. 15]. Being realistic does not imply making sacrifices at the altars of private enterprise, laissez faire, prevailing legislation, or practical politics. In particular, it does not mean presupposing that private enterprise or lack of regulation must be perpetuated even where they work badly. Suppose, for example, that one believes that price should equal marginal cost wherever marginal cost is zero. Then it would be apologetics, not realism, for him to suppress the idea on the ground that it is inconsistent with private enterprise; and it would be defeatism, not realism, for him to suppress it on the ground that the Congress will not listen.

Apologetics could be alleged if a writer scaled down his demands to comply with another restriction proposed by Bain. He asserted, "The essential limits of the performance of enterprises within a capitalist economy are those of adjusting to whatever effective demands are present for their outputs, with the restriction that in so adjusting they must as a group at least 'break even'—that is, not incur bankruptcy en masse and thus make private enterprise impractical" [4, pp. 11–12]. Clearly, this limit precludes $P = MC = 0$. (It might be added that private enterprise has survived in a number of industries that seem not to break even. Apparently, hope springs eternal, and more cannon fodder keeps arriving.)

Defeatism could be alleged if one scaled down his demands to comply with Markham's restrictions. Markham advocated "recognizing at the outset the political and economic limitations placed upon policy-making authorities" [41, p. 361]. To do this would create one restriction. Another restriction would arise from treating by-gones as by-gones, as is done in the concept of workable competition that Markham presented. To illustrate the effect of these restrictions, suppose that an industry's plants were built at inefficient locations. The industry could, nevertheless, be effectively competitive by Markham's standards. This conclusion would follow if the only remedy were to create a public or private monopoly but political limitations excluded this remedy. The conclusion also would follow if it did not yet pay to correct the mistake. In neither case would I want to call the industry *effectively competitive*; its state is not ideal.

Be discriminating

A writer should state whether each condition that he approves was selected because he believes that it has desirable effects or because he regards the condition as desirable in itself. In other words, he should indi-

cate why he is approving of each condition, whether he approves because he thinks that the condition has laudable effects (as might be the case with individual price setting), or because he finds the condition laudable for its own sake (as might be the case with nondeceptive packaging, which he might favor not because of, or not only because of, or even despite its effects).

If a writer is not, in this sense, discriminating, he will make it more difficult for others to offer the kind of reaction that can lead to progressive refinement and ultimately, perhaps, to a consensus. For example, one of the 15 criteria that Moore and Walsh adopt is "entry as free as the nature of the industry permits" [46, p. 382]. It would be helpful to know why. They may approve of free entry only because of what they believe are its effects (for example, its effect on profits). If so, the merit or validity of their position, to them and perhaps to others, would depend in part on what really are the effects of free entry. (In addition, validity would depend on whether those effects are regarded as desirable.) Knowing this, a reader could anticipate that Moore and Walsh would withdraw their approval of free entry if he could present compelling evidence that their impressions about its effects are not correct (for example, compelling evidence that, with free entry, profits often are not what Moore and Walsh think they should be—high enough to "reward investment, efficiency, and innovation" [46, p. 382].

On the other hand, Moore and Walsh may approve of free entry partly or wholly for its own sake (for example, because they regard it as an aspect of equality of opportunity). If so, the validity of their position, to them and perhaps to others, would not depend on whether certain propositions are true or false. Knowing this, a reader could anticipate that evidence alone would not suffice to make Moore and Walsh change their minds. He might, nevertheless, undertake to show that free entry has effects which, at least for him, are undesirable (for example, chronic losses and excess capacity in some industries). But he would realize that, even if he convinced Moore and Walsh that these effects did follow from free entry, and even if they too disliked the effects, they might maintain their position, feeling that the intrinsic merit of free entry outweighed the deleterious effects.

These comments presuppose the impossibility of a writer's showing that he is right in approving or disapproving of various market conditions; perhaps this point should be made explicit. The most that a writer can do to justify his position is to show that the conditions he is specifying have certain effects. He may be able to go on and show that these effects, in turn, have other effects. Sooner or later, however, he can only be dogmatic. That is, if, step by step, he tries to answer the question, "Why is *that* desirable?" he will, at some point, find himself able to say only, "Be-

cause that is a goal in our society," or "Because I like it," or "Because my Authority says so."

Indeed, even if a writer takes his personal version of social goals for granted, he still cannot show that he is right. It is possible for a writer simply to postulate that various basic objectives are appropriate.⁵ Even so, in the present state of knowledge, he cannot show that his approval or disapproval of various market conditions follows from those objectives. To show this, he would need to demonstrate that the conditions that he approves or disapproves militate for or against attainment of the objectives. At present, this is not possible. Too little is known about how markets function to be sure about the effects of various conditions.⁶ Furthermore, many market conditions will have mixed effects—some favorable, some unfavorable. Thus, a single-firm industry—indeed, a single-firm economy—may be favorable to cost minimization, resource conservation, and war mobilization, but unfavorable to output composition, product quality, and technological improvement. To ascertain the net impact of a market condition on the attainment of some postulated social goals, a writer would need to quantify and weight the effect on each goal. This degree of precision is not likely to be achieved in the near future. In any case, there is no easy way to weight or compare effects on competing goals. Dirlam and Kahn put the point very well: "It is not true, even though Adam Smith said it and even though his saying it was salutary at a time when public policy was excessively indifferent to the principle, that 'consumption is the sole end and purpose of all production.' We all have interests as producers (or as citizens of an urbanized civilization) as well as interests as consumers. Conflicts—particularly between the values and interests of producers and consumers, or between this group of producers and that, or between 'economic welfare' and other values—are the order of the day.

⁵ Bain, for example, declares, "The principal dimensions of the aggregate performance of the economy . . . are (a) the volume of employment . . . ; (b) the efficiency of production . . . ; (c) the relative stability . . . ; (d) the rate of growth . . . ; (e) the composition of aggregate output . . . ; and (f) the distribution of income" [4, p. 13].

⁶ Does not polypoly (many sellers) produce a price equal to marginal cost and to minimized average cost? Yes, it does—in a world with profit maximization, rationality, information, certainty, homogeneity, divisibility, stability, recontract, instantaneous adjustment, zero transport and transaction costs, and other convenient characteristics. Whether any conclusion based on such assumptions holds in real markets, however, is uncertain, to put it mildly. One often hears it said that "the" price with oligopoly will lie between "the" price with polypoly and "the" price with monopoly. In fact, however, oligopolists' prices may exceed the level that an equally profit-minded monopolist would choose, that is, may exceed the level that joint-profit maximization would dictate. One reason among many is that no one may dare to rock the boat. The basic point about joint-profit maximization holds even when a formal organization exists. Dewey made the point beautifully: "To state what a cartel must do in order to maximize profit is to suggest why, in fact, cartels never achieve—or even seriously seek—this goal" [20, p. 14].

They are resolved pretty much on the assumption that neither one side nor the other invariably takes precedence" [21, p. 18].⁷

Because a writer cannot show that he is right in approving or disapproving of various market conditions, his concept of effective competition will be subjective, resting on his own attitudes and beliefs. His concept may, nevertheless, be valid for other people. All commentators now agree that some market conditions (for example, rational buying) are socially desirable and that others (for example, false advertising) are socially undesirable. Ultimately, all concerned may agree about all market conditions. It will not matter whether they agree for the same reasons or for different reasons.⁸ If they agree, all concepts of effective competition but one will have become irrelevant. The existence of a common folklore works in this direction. For writers to be discriminating also will help.

Be comprehensive

A writer should include in his list of necessary conditions of effective competition the absence of every market characteristic that he regards as avoidable and undesirable. In other words, he should list all kinds of deficiencies; more than "excessive market power" is relevant.⁹

If a writer is not, in this sense, comprehensive, he will reduce the value of his concept of effective competition. It will fail to direct the attention of people who investigate particular markets to all issues that (at least to him) are important, and it may even lead them to claim that the state of

⁷ For some purposes, such as evaluating the extent of product variety, one may be able to amalgamate his competing goals by adopting the Pareto criterion (or the welfare criteria proposed by Kaldor, Hicks, Scitovsky, or Little). Even so, it is no easy task to identify the persons who, now and in the future, stand to gain and those who stand to lose from a possible change, to ascertain the monetary values they place on their gains and losses, and to decide how to weight these money values.

⁸ People can reach the same value judgment by entirely different routes. For example, people may agree that price fixing is undesirable even though they do not agree that price fixing militates against efficient production and do not agree even that efficient production is desirable. They may object to price fixing on the grounds that it fosters supernormal profits, which they regard as undesirable. It may not be flattering if a writer is regarded as "right" for the "wrong" reasons, but it would be sufficient to make his conclusion acceptable.

⁹ Many traditional terms are metaphysical, for example, *market power*, *competition*, and *monopoly*. That is why I am avoiding these words. Cochrane's definition of *market power* may be the most usable: "the ability of firms to pursue market policies independent of their competitors" [18, p. 401]. The trouble is, as Adelman said, that "control over prices . . . is present to some extent everywhere" [1, p. 1304]. Ignorance and distance probably are the most important reasons. Farris has shown how country elevators in the same county and even the same town pay different prices for wheat, corn, and soybeans [25]. Since market power is ubiquitous and unmeasurable, I do not find it helpful to speak of excessive amounts of it. Similarly, references to competition and to monopoly are not likely to help if, as Adelman declared, "a proper blend of competitive and monopolistic elements is needed in any particular market to produce workable competition" [1, p. 1303].

a particular market is, by his standards, socially desirable although that market has characteristics that he regards as serious deficiencies.

For example, Wilcox makes it clear that he regards fraud and other unfair methods of competition as outrageous [78, Chap. 24], but he does not mention the subject when presenting his concept of effective competition [78, p. 252]. As a result, an investigator is not reminded to examine the plane of competition, and he may conclude that a particular market is, despite widespread fraud, in a state that Wilcox would regard as socially desirable.¹⁰

It is, I concede, not customary to treat every kind of deficiency as relevant. The usual practice is to define *effective competition* in terms of a few variables labeled *strategic*, that is, in terms of a subset of the market variables with normative significance. For some writers, the subset consists mostly or entirely of performance variables—most commonly, efficiency, profits, and progress. For other writers, the subset consists mostly or entirely of structure and conduct variables—most commonly, concentration, ease of entry, and collaboration.

A few words on terminology are in order here. I am using the words *performance*, *conduct*, and *structure* in Bain's sense, with two qualifications. According to Bain, "Market structure for practical purposes means those characteristics of the organization of a market that seem to influence strategically the nature of competition and pricing within the market" [4, p. 7]; "market conduct refers to the patterns of behavior that enterprises follow in adapting or adjusting to the markets in which they sell (or buy)" [4, p. 9]; and "market performance encompasses the strategic end results of the market conduct of sellers and buyers" [4, p. 372].

My first qualification results from Bain's rejection of an interpretation of his definition of *structure* that I regard as consistent, convenient, and appropriate. "At times," he writes, "market structure has been defined much more broadly—e.g., as 'the economically significant features of a market which affect the behavior of firms in the industry supplying that market.' So construed, market structure could embrace every objective circumstance—psychological, technological, geographical, or institutional—that might conceivably influence market behavior. According to this definition, every market has a multitude of characteristics, and every market is in some degree structurally unique" [4, p. 9]. Bain prefers, in contrast, to identify only from four to seven dimensions of structure [4, p. 301].

This limitation has produced discomfort even for some of Bain's most enthusiastic adherents [17, p. 517]. If I were to abide by the limitation, I would need to create a new category for many variables that I think need

¹⁰ Clark, it should be noted, does require "conformity to the basic morals of trade, including furnishing dependable information" [14, p. 479].

attention, such as the transaction system (administered pricing, English auction, Dutch auction, etc.). Excluding the transaction system from the structure category seems both unnecessary and inconvenient. Instead, I prefer to interpret Bain's definitions in game theory terms, which are broader.

My interpretations or translations are as follows: *structure* denotes all predetermined characteristics of the game and its players that constrain the players' choices; *conduct* denotes all choices or strategies that the players adopt; *performance* denotes all consequences of the players' choices that are, to them or others, payoffs of the game. This view of structure, I might add, follows Mason's original approach: "The structure of a seller's market, then, includes all those considerations which he takes into account in determining his business policies and practices" [43, p. 65].

My second qualification concerns one of the dimensions of structure that Bain does identify (and stress), namely, concentration of sales (or shipments). I do not regard this variable (or rather function) as an aspect of structure.

If suppliers administer prices, as is usual, their shares of total sales are, like profit rates, a consequence of their decisions as to prices and of buyers' decisions as to purchases. Even when sellers predetermine the quantities they will sell, as often occurs at auctions, the distribution of sales still is a consequence of choices, namely, sellers' choices. As a result, concentration of sales is not a characteristic of the organization of the market. Concentration of sales does fit one of the definitions, but it is the definition of *performance*, not *structure*.

Concentration of sales can represent an organizational characteristic in a very different sense. If concentration of sales has a high positive correlation with concentration of capacity (or of inventories), it can, when data on the latter are lacking, be used as a proxy for the latter, that is, as a proxy for a structural variable. Even then, one should be careful to distinguish the proxy from the real thing. The essence of the process of competition consists of the events that transform supply into sales. The proxy relates to sales; the real thing relates to supply.

In one sense, I agree with the writers whose concepts of effective competition relate to performance variables. I, like them, do not believe that satisfactory conditions of concentration, ease of entry, collaboration, and other aspects of structure and conduct necessarily imply that efficiency, profits, progress, and other aspects of performance also will be satisfactory. One reason is that it is very hard to say when concentration or ease of entry is satisfactory; one among many problems is that efficiency and profits may make conflicting demands. Another reason is that the aspects of structure and conduct that can be evaluated do not

determine performance; managers always have a range of alternatives open, and their choices may be, by others' standards or even by their own, mistakes. Managers may, for example, regardless of the market's structure, build plants at locations that are socially inefficient and even unprofitable.¹¹

Yet I also agree with the writers who refer to conduct and structure variables. Like them, I do not believe that a satisfactory state of efficiency, profits, progress, and other dimensions of performance necessarily implies that collaboration, tie-ins, information, or other dimensions of conduct and structure will be satisfactory too. One reason is that performance may merely *appear* satisfactory; for example, progress may be rapid only in comparison to industries with fewer opportunities. Another reason is that performance may be satisfactory only by accident; for example, inflation may neutralize resale price maintenance. Finally, performance in the past—even the recent past—may be irrelevant; for example, a merger may just have occurred.¹²

Accordingly, I agree with the writers (such as Bain) who refer to all three parts of the performance-conduct-structure triad in defining *effective competition*.¹³ But even these writers have not been comprehensive.

¹¹ As phrased, both "reasons" given in this paragraph stress the importance of nonprice aspects of performance. In addition, one can and should challenge the "structuralists" on their own ground, that is, pricing. Backman has done so very persuasively. "Pressure on prices," he asserted, "has reflected—(a) New entrants into the market (e.g. computers, organic chemicals) (b) the price cutting proclivities of smaller companies (aluminum fabricated products); (c) the search for volume by large companies (paper and electrical equipment); and (d) the development of substitute products with the accompanying expansion of the scope of the market (e.g., plastics). These illustrations underline the importance of using concentration ratios with great care because high ratios are found in each of these industries. [Structure] alone has neither determined . . . price behavior nor made it predictable" [2, p. 268].

¹² Lewis presents a fourth reason: "I am not willing to judge . . . effectiveness . . . solely or even largely on the basis of 'results.' . . . Results alone throw no light on the really significant question: have these results been *compelled* by the system. . . . For competition to be effective [the] array of price and output policies from which managements are free to choose must be strictly limited. Satisfactory results which . . . might not have happened are not good evidence of the successful working of an economic system. . . . I want the decision on prices to be made by society—either through the compelling forces of a competitive market or . . . by the action of a responsible government. [No such] force characterizes . . . industries . . . dominated by . . . a few large firms. . . . To speak of *potential* competition as a compelling regulatory force in this situation is to be blind to the strength of the factors that retard . . . the drive of potential competition to become actual competition" [38, pp. 706–707]. I do not agree. Since it is not possible to have satisfactory results compelled, Lewis' argument leads to a demand that government decide prices. I am not persuaded that better results would come from government than from oligopolists who have a wide range of possible action—even with respect to pricing, which I view as a relatively unimportant issue in a nonstatic world.

¹³ Bain states, "The primary meaning of workable competition . . . is workable

For example, rarely have they mentioned dishonesty, externalities, irrational buying, or frequent work stoppages. Exclusion of such issues is, I think, simply a bad habit. It arises from the practice of regarding effective competition as the antithesis of monopoly, and from regarding monopoly as a socially undesirable situation that exists when a market's structure lacks some of the characteristics that serve to define perfect competition (in particular, polypoly, homogeneity, and free entry), or that exists when a market's performance lacks some of the features that characterize a long-run equilibrium with perfect competition (namely, minimum costs, zero profits, and a single price equal to short-run and long-run marginal costs).

In contrast, I regard effective competition as the antithesis of a socially undesirable market situation, and I see many reasons why a market situation may be undesirable even with polypoly, free entry, and minimum cost. There is, in my view, no reason to confine attention to a few variables that would constitute the matters of social concern only in a mythical world where nothing changes. Instead, a writer should decry every market condition that he regards as avoidable and undesirable.

Be stringent

A writer should refuse to moderate his necessary conditions of effective competition merely to increase the number of markets that can be labeled *effectively competitive*. In other words, a writer should not water down the ideal that he presents any more than he already must in order to make the ideal realistic (that is, in order to make its necessary conditions attainable in every market).

If a writer is, in this sense, stringent, a market will be effectively competitive by his standards only if it has no deficiencies whatever. This result may seem strange. The alternative, however, is to introduce tolerances, and tolerances create trouble. They are subjective, and they invite investigators to label markets *effectively competitive* even if those markets have remediable defects.

For example, Bain proposes to "classify as having unworkable performance any industry with extreme divergence from ideal performance in one or more important dimensions; as having workable performance any industry having no more than minor divergences in any dimension; as probably having unworkable performance any industry with moderate divergences in several dimensions" [4, p. 16]. To apply this proposal to a real market, an investigator cannot simply itemize whatever divergences

performance. . . . There is also, however, a derived meaning of workable competition, and this refers to patterns of market structure and conduct which may be expected to give rise to . . . workable performance" [4, p. 16].

from Bain's ideal exist; he also needs to judge whether the divergences are minor, moderate, or extreme. It then becomes a matter of judgment whether a particular market meets Bain's standard. An investigator may, moreover, decide that various divergences are minor even though public policy could readily and inexpensively correct them—a situation which I, like Markham, think should be called to public attention. Attention is gained by assigning an unfavorable label (such as *ineffective competition*), not by assigning a favorable label (such as *effective competition*).¹⁴

The point is not that one who examines a particular market should avoid assessing the importance of deficiencies. The point is that in presenting his concept of effective competition, one should not make such assessment part of what investigators must do in order to decide whether particular markets are, by his standards, effectively competitive. The essential task of an investigator is to itemize whatever deficiencies he uncovers. If he chooses to go on to characterize the deficiencies as major or minor, that is fine. If not, others can do so if and when the need arises. A writer should not impose the chore by including tolerances.

The point, let me add, has nothing to do with how stringent I think antitrust law should be. In particular, I definitely am not advocating that the law forbid every market condition that some consensus regards as avoidable and undesirable. To try to make every deficiency unlawful would be very unwise. There are several reasons. First, prohibitions entail investigation and litigation; the costs should be weighed against the benefits for individual issues. Second, some prohibitions (for example, limits on concentration) would be self-defeating; they would impair incentives. Third, many structure and performance conditions (such as inefficient locations) may be no one's fault; prevalent standards of fairness dictate that no penalties be imposed unless there has been forewarning and either intent or negligence [9, 21, 55]. The last point, especially, is a good reason for retaining the present approach of antitrust law, that is, to forbid only objectionable conduct, not objectionable structure or performance.¹⁵ It is also a good reason for supplementing antitrust law with a positive approach, such as mandatory grade labeling.

¹⁴ Bain's concept of *ideal performance*, I should add, is stringent. "Ideal performance," he writes, "is found in adaptations of enterprises to their markets which enhance to the maximum possible degree the attainment of . . . overall economic objectives" [4, p. 14]. By considering that Bain's concept of effective competition refers to ideal performance instead of to workable performance, one can conclude that the concept he presents is indeed stringent.

¹⁵ The conduct that antitrust law forbids includes some acts (for example, price fixing) that only at times are objectionable, that is, that only at times inflict unjustifiable injury. This, too, is reasonable. To make some acts illegal per se reduces uncertainty; it also makes enforcement less expensive and capricious. A rule-of-reason approach, in contrast, invites an interminable inquiry into the effects of the suspicious behavior in each case.

My Concept of Effective Competition

My use of the general principles

Four of the seven principles discussed above will be easy for me to follow and three will be difficult.

To be explicit will be easy. I will simply itemize various conditions that I regard as flaws and state that the absence of each of these flaws is necessary for a market to be, by my standards, effectively competitive, while the absence of all of them together is sufficient.

To be stringent also will be easy. I will add no tolerances. I will state that a market is, by my standards, effectively competitive only if it has none of the flaws.

To be specific will be easy too. I will classify the various flaws in a way that permits each deficiency to be viewed as an objectionable state of a particular variable. For example, I will classify a deliberately shortened product life as an unsatisfactory state of product quality.

To be discriminating also will be easy. I will simply divide the flaws into two kinds—those that I regard as undesirable both in themselves and in their effects and those that I regard as undesirable only because of their effects. Since it has become conventional to classify market characteristics, not in this way, but in terms of performance, conduct, and structure, I will also cross-classify the two kinds of flaws in those terms.¹⁶

To be realistic will not be easy. Many attributes often considered optimal (such as equalized marginal rates of substitution and minimized average costs) are equilibrium conditions whose constant attainment is not possible in a dynamic world. One cannot decry every departure from such equilibrium conditions if he wants to decry only those defects that always can be avoided. But neither can he ignore the issues involved. I will try to compromise by referring to departures that, because they are within people's control, are avoidable.

To be comprehensive also will be difficult. It will require anticipating and mentioning every characteristic that a market might have that I would regard as avoidable and undesirable. Success in this respect is especially unlikely, and I hope that readers who think my list incomplete will suggest additions.

To be definite also will be difficult. To decry only those market characteristics that I invariably would object to, I must anticipate extenuating circumstances and indicate that a characteristic is objectionable only when the extenuating circumstances are not present. I hope that readers

¹⁶ It will be seen that, of the 10 classes that I regard as undesirable both in themselves and in their effects, 7 are components of performance and 3 are components of conduct. Of the 15 classes that I regard as undesirable only because of their effects, 1 is part of performance, 11 are parts of conduct, and 3 are parts of structure.

who have counterexamples, that is, who can mention additional extenuating circumstances, will do so.

My criteria for effective competition

A market is effectively competitive by my standards if, and only if, it is free of 25 kinds of flaws. Each of the 25 is a class of market conditions that I regard as avoidable and undesirable in any market.¹⁷ The flaws fall into two groups: 10 are conditions that I regard as undesirable both in themselves and in their effects, and 15 are conditions that I regard as undesirable only because of their effects.

With respect to an item in either part of the list, a reader may feel that I am "right" for the "wrong" reasons. Explanations are, consequently, inessential. They are, nevertheless, interesting, and they may even be persuasive. Defenses of my position, however, will be brief because we could not finish if we gave each issue the treatment it deserves.¹⁸ When no defense is given, the reader can assume that what I have in mind is that the Kaldor welfare criterion would be satisfied: the persons who would be better off if the condition at issue had been avoided would be better off even if they had to compensate everyone who would be worse off.

Conditions considered undesirable both in themselves and in their effects

Of the ten market characteristics which I regard as undesirable both in themselves and in their effects, the first seven relate to performance and the last three to conduct.

1. *Unsatisfactory products*: needless reduction of durability; suppression of new products;¹⁹ incomplete standardization;²⁰ needlessly hazardous or uneven quality.²¹

2. *Underuse or overuse*: administering prices at levels that are unprofitably high,²² or at levels that reduce purchases even though marginal cost

¹⁷ By a *market* I mean an environment in which exchange occurs. Which activities a particular market includes can, for most purposes, be decided more or less arbitrarily.

¹⁸ I have elaborated elsewhere on many of the issues [64].

¹⁹ For illustrations of suppression and quality reduction, see Stocking and Watkins [71]. In the United States and certain other countries, a patentee may refrain from using his invention yet deny it to others.

²⁰ Some product characteristics (for example lamp sockets and size names) are unrelated to taste or service; others (for example, sizes and containers) are related but benefit no one by varying without pattern. If competitors fail to adopt standardized specifications for such product characteristics, higher costs result for distributors and consumers [71].

²¹ Other product deficiencies might be mentioned, namely, low quality, inadequate variety, overfrequent restyling, slow improvement, and excessive distributive services. However, I do not see how the existence of any of these deficiencies can be demonstrated objectively. Each seems to require a judgmental comparison of benefits and costs.

²² Perhaps because of miscalculation, a high-cost price leader, fear of price war, or government regulation.

is nil and financing and evaluation do not require charging consumers, or at levels that are larger multiples of short-run marginal cost than occur for any important substitute,²³ or at levels that are below short-run marginal cost;²⁴ failing to increase capacity when price averages a larger multiple of long-run marginal cost than occurs for any important substitute; failing to phase out capacity when price averages less than long-run marginal cost.

I have omitted the classic case in which price simply exceeds marginal cost. The primary reason for the omission is that this inequality does not imply underuse of the product, that is, does not imply what often is called "restriction of output." Given that price does not equal marginal cost in other markets, it would not be Pareto-optimal to have price equal to marginal cost in the market under consideration. This negative conclusion follows from the general theorem of the second best, namely, that violation of one requirement of a Pareto optimum generally makes fulfillment of other requirements nonoptimal. Even if departures elsewhere in the world are not taken as given, nothing can be said. The theory of the second best also indicates that it would be impossibly complicated to ascertain whether the quantity sold in any one market would increase or decrease if, for every product, price were to become equal to marginal cost. By refusing to include a denunciation of $P > MC$, I probably have condoned the level of use that exists in most markets. This result will, I expect, please some readers and disturb others. As Peterson has said, "Economists who stress the nice equating of marginal results are more alarmed by monopoly elements than are economists who stress productivity and progress. The former also have a stricter idea of what reasonable profit means" [53, p. 77]. For the benefit of "the former," I should add that the social loss resulting from mispricing in American manufacturing has been estimated to be well under 1 percent of national income [31, 60, 61, 68]. It is easy to forget that, despite oligopolies, resources are allocated and reallocated—and would be even with the worst possible mix of monopolies and polypolies.

3. *Inefficient exchange*: giving buyers no opportunity to choose less costly alternatives;²⁵ needlessly enlarging transaction costs;²⁶ wasting by-products; imposing price ceilings or floors that create queues or surpluses; failing to transmit retail price differentials to primary markets; maintaining price differences between markets in excess of transfer costs;

²³ The important substitutes for coal, for example, would be gas and electricity [39].

²⁴ Perhaps because of miscalculation, a price war, government regulation, or overplanting.

²⁵ For example, less frequent deliveries [16, 76].

²⁶ Perhaps because outlets are spaced inconveniently, because market places are mislocated or congested [10], or because exchange involves needless search, haggling, or waiting.

pairing sellers and buyers in a way that does not maximize a measure of traders' collective gain from trade in the market net of transaction costs.²⁷

4. *Inefficient production*: locations, shipments, techniques, integrations, scales, utilizations, and inventories that needlessly waste resources. Economists have formulated a variety of requirements for cost minimization. An example is the requirement that output be apportioned among plants in a way that equalizes (rising) marginal costs. These requirements should be used to identify problems but not to define solutions, for four reasons. First, only if certain simplifying assumptions are made are the requirements really necessary conditions of cost minimization. In practice, uncertainty, heterogeneity, indivisibilities, and growth justify departures. Second, fulfilling the requirements is sufficient for cost minimization only if other assumptions hold. The requirements do not cover problems such as needless transactions, trade secrecy, and suppression of innovations. Third, minimizing costs is not always conducive to maximizing social product. Pecuniary costs differ from real costs if produced inputs are mispriced or if unemployment is pervasive. Fourth, some outlays—for example, insurance, lobbying, carpets, guard rails, seniority costs—may be justified, not by greater output, but by security, prestige, or other objectives. Accordingly, I am willing to condemn total costs in excess of the level required by the quantity and quality of industry output only if the excess represents a needless waste of resources, that is, only if the excess implies a reduction in other output, serves no purpose, and results from avoidable causes, such as apathy, bad judgment, or [8, 32] decentralized decision making.

5. *Bad externalities*: inflicting costs or denying benefits when the persons affected could, with mutual advantage, contract out of the situation if negotiations were feasible [33, 72].

6. *Spoliation*: needlessly exhausting a self-renewing resource [13]; inefficiently extracting, using, or developing substitutes for a nonrenewable resource.²⁸

7. *Exploitation*: working conditions that are needlessly dangerous, uncomfortable, insecure, or oppressive; inefficient or discriminatory placement or training; obstruction of organization or refusal to bargain; unions that are corrupt, undemocratic, or discriminatory or that violate contracts or refuse to bargain; employees who steal, disobey, make work, or strike for illegitimate purposes; work stoppages that imperil public safety or that arise because contract interpretation is not subject to arbitration; inflationary settlements where wages already exceed comparable rates.

²⁷ Perhaps because of systematic price discrimination or [12, p. 247] because of price variation associated with sequential pairing of sellers and buyers.

²⁸ I have omitted overrapid depletion of a nonrenewable resource, because I think that uncertainty concerning new discoveries undermines any calculation of an optimal time pattern of depletion.

8. *Unfair tactics*: malicious interference with competitors; fraud against customers or suppliers; sale of inherently useless or dangerous products without notice.

9. *Wasteful advertising*: using resources for advertising that is false, misleading, or valueless to its audience.²⁹

10. *Irrationality*: self-defeating choices by buyers or sellers.³⁰

Conditions considered undesirable only because of their effects

Of the 15 market conditions which I regard as undesirable only because of their effects, the first relates to performance, the next 11 (numbered 2 through 12) relate to conduct, and the last 3 (numbered 13 through 15) relate to structure.

1. *Undue profits or losses*: positive profits for all competing sellers when some of them have an inferior combination of quality and costs or when industry capacity is excessive; negative profits for all competing sellers when some have a superior combination of quality and costs or when industry capacity is inadequate.

The prevalent view is, I realize, quite different. Bain, for example, regards it as undesirable for an industry's profits, net of imputed interest and other implicit costs, "chronically" to be positive [4, p. 402]. I cannot agree.

First, I do not see how to identify unjustified profits. I think that an investigator will find, in every industry's history, product innovation, cost reduction, shifting demand, and the risk of ultimate failure, that is, of creative destruction, as Schumpeter put it [59]. I think that each of these factors justifies some amount of profit, and I see no way to tell when the amount or duration of actual profits has exceeded what the record justifies.

Second, even if unjustified profits can be identified, I am not prepared to condemn them. I find neither the allocation nor the distribution argument persuasive.

The allocation argument is that positive profits imply underuse. But the

²⁹ Instead, one might, following Bain, denounce promotional outlays that exceed 5 percent of sales [4, p. 416]. This approach, however, would tolerate skywriting provided that it cost less than 5 percent and would condemn catalogs whenever they cost over 5 percent. Concerning catalogs and other types of informative advertising, I think we should recognize that, in principle, they can be carried to excess, but in practice we have no valid test of when they are excessive.

³⁰ Markham undertook to measure the loss for fertilizers: "The social costs of such irrational buying can be measured in terms of the difference between the farmers' total outlays on mixed fertilizer and what they would have been had farmers bought the same plant nutrients in the cheapest grades available" [42, p. 188]. The difference in 1950 was \$60 million, or 10 percent [42, p. 194]. If the leading sellers happen to offer the most favorable terms and buyers choose rationally, both concentration of sales and stability of market shares will increase. I accept both implications. Others may not [30].

argument makes the questionable assumption that price would equal long-run marginal cost if it equaled average total cost. Even if this were true, price equal to long-run marginal cost would be Pareto-optimal only if long-run and short-run marginal cost were equal, only if other prices also equaled short-run marginal costs, and only if there were no externalities. Even if these conditions were met, there remains the problem that, because of distributional differences, a Pareto optimum is not necessarily better, even by the Pareto criterion, than a position that is not a Pareto optimum.

The distribution argument is that positive profits increase inequality. But the argument forgets that sellers may be dressmakers and buyers duchesses, that new fortunes imply upward mobility, that occasional high returns may increase the supply of venture capital and reduce aggregate profits, that equities compete with other types of earning assets, that profits net of taxes and imputed interest average less than 5 percent of U.S. rational income [4, p. 408], and that a preference for buyers' surplus over sellers' surplus is subjective.

On these grounds I have rejected any attempt to evaluate the level of an industry's profit rate. Instead, I have referred to the distribution of profit rates. The reason is that, if all sellers have positive rates of profit, the least efficient are not being driven out; if, on the other hand, all have negative profits, even the most efficient may be driven out because they lack financial resources.³¹

2. *Inadequate research*: no personnel whose full-time job is to seek ways to improve products or reduce costs. Unfortunately, as Bain points out [4, p. 420], there seems to be no good way to evaluate the *results* of research and development, that is, no objective test of satisfactory progressiveness. To denounce a failure of unit costs to decline at an above-average rate would overlook the fact that cost reductions may be easier to achieve elsewhere. To denounce less progress than was possible would merely rephrase the question, that is, would not specify a verifiable market characteristic.

3. *Predation*: deliberately making one's price for a product be less than his per-unit avoidable and separable cost,³² or deliberately making one's

³¹ Two points should be added. First, I refer only to sellers' profits because, even if buyers are companies and have profits, their profits can best be considered with respect to the products they sell, not the many inputs they buy. Second, the phrase *competing sellers* needs definition. By *competing sellers*, I mean companies that would find it unprofitable to ask a price that is more than 20 percent above the highest price asked by the others (except during periods when the others are rejecting new customers). I mention 20 percent because I am trying to be definite. The alternative is to speak glibly of an industry, to pretend that it can be delineated without adopting some equally arbitrary criterion, to leave the criterion for some one else to choose, and therefore to fail to be concrete.

³² By *separable costs* I mean current outlays, plus an allocated part of past out-

revenues for a set of joint products be less than his avoidable costs for the set of products, when the price-cutter or cost-raiser intends to injure and does injure one or more financially weaker competitors or when he (without such intent) creates or enlarges negative profits on the relevant products for financially weaker competitors (and is not merely unloading excess inventory or meeting competition in good faith).

4. *Pre-emption*: acquiring patents, inputs, outlets, or future orders with the purpose and effect of hindering actual or potential competitors.

5. *Tying arrangements*: conditioning licenses, sales, discounts, or purchases on other dealings with the company or on not dealing with other companies. This description is intended to cover such things as exclusive dealerships, full-line forcing, tie-in sales, block booking, and reciprocal dealing.

6. *Resale price maintenance*: imposing minimum or maximum resale prices.³³

7. *Refusals to deal*: refusals that are concerted with other companies, designed to punish aggressive marketing, used to perpetuate established channels of distribution or previous pairings of sellers and buyers,³⁴ or intended to keep certain people "in their place."

8. *Undesirable discrimination*: similarities or differences in terms of sale to different patrons that are not justified by costs, changing conditions, or meeting competition [73] and that either imperil smaller patrons or disadvantage certain areas or methods of production.

9. *Misallocation of risk*: expressed or implied warranties that are less complete than principles of insurance demand; cost-plus procurement that needlessly invites carelessness; substitution of consigning for selling when the merchandise is not novel and the consignor is not better able to use unsold stocks or to offset losses.³⁵

10. *Undesirable collaboration*: refusals to cooperate that needlessly undermine efficiency; agreements to cooperate that needlessly undermine aggressiveness. The first phrase refers to rejecting trade associations, conferences, or other vehicles of joint action that would reduce fraud, improve grades, promote standardization, foster conservation, facilitate recruitment, disseminate information, etc. The second phrase refers to mak-

lays, that were incurred in order to increase the sales of a single product. By *avoidable costs* I mean outlays that the producer could escape by ceasing production. Avoidable costs, therefore, include both variable costs, such as outlays for livestock, and discretionary fixed costs, such as advertising and executive salaries; they exclude nondiscretionary fixed costs, such as bond interest and time-based plant depreciation.

³³ Resale price maintenance is the best studied of all the conditions on my list. The relevant literature is too extensive to cite.

³⁴ For example, physicians expect a patient to obtain permission before seeking advice from other doctors; investment bankers respect each other's affiliations.

³⁵ Consigning often replaces selling in order to overstock shelves or to avoid turnover taxes. It also exists at times simply because it is traditional.

ing arrangements to pool profits, assign patrons, restrict production, fix prices, expose price cutters, or obstruct entry, each of which I think needlessly reduces the correlation between survival and efficiency. (For contrasting views, however, see Bain [4, p. 344] and Dewey [19].) The second phrase also refers to having interlocking directors and officers.

11. *Undesirable mergers*: vertical or horizontal combinations that do not reduce costs and that either create opportunities to injure competitors by foreclosure, squeezing, or discriminatory sharpshooting [22] or else leave fewer than three competing sellers.

The prevalent view in this connection is quite different from mine. It stresses, not the number of competitors, nor the means by which the existing number is being reduced, as I do, but the existing concentration of sales. Kaysen and Turner, for example, would impose divestiture "where, for five years or more, one company has accounted for 50 percent or more of annual sales in the market, or four or fewer firms have accounted for 80 percent"—unless the existing concentration is attributable to scale economies, innovations, or extraordinary efficiency [34, p. 267].

Statistical analysis supports this prevalent view, in the sense that available evidence is consistent with the hypothesis that profit rates have a higher conditional expectation if the four leading sellers account for more than 50 percent of sales than if they account for less [3, 5, 24, 28, 36, 37, 40, 47, 49, 56, 58, 65, 69, 77]. The evidence, however, is far from conclusive. Data have not been available even for 5-digit product classes; inappropriate measures of profits have been used; the correlations obtained are low; the functional relation is unknown; the relative importance of number of sellers and of inequality is virtually untested; the impact of trend in demand, concentration of demand, easy self-supply, easy entry, close substitutes, and low value added is unclear. Some of these considerations led Kaysen and Turner to add that their "arbitrary definition would cover some situations in which substantial market power did not in fact exist" [34, p. 268].

A second objection to the prevalent view is that, as noted above, higher profits are not necessarily objectionable. To argue that they are objectionable simply because they are correlated with concentration [4, p. 449] is both to argue circularly and to ignore the point (made by both J. M. Clark [15, p. 250] and Joan Robinson [57, p. 254]) that profits in unconcentrated industries may be negative.

A third objection to the prevalent view is the most important: little is yet known about the implications of high concentration for matters far more important than profits—not only efficiency of production, but progressiveness, sales promotion, efficiency of exchange, product suitability, and labor relations. Some of these considerations lead to Schumpeter's famous observation: "It is not [price, quality, or promotional] competition which

counts but the competition from the new technology, the new source of supply, the new type of organization. . . . [The latter are] so much more important that it becomes a matter of comparative indifference whether competition in the ordinary sense functions more or less promptly; the powerful lever that in the long run expands output and brings down prices is in any case made of other stuff" [59, pp. 84-85]. (For critical comment, see Mason [43, Chaps. 5, 17].) These three objections to the prevalent view lead me to reject any attempt to specify avoidable and undesirable states of concentration. Instead, I refer to mergers, which always are avoidable and always shift the concentration curve leftward. Two points about my norm need comment.

First, I decry mergers that reduce the number of competing sellers—a phrase defined earlier—only if they make the number less than three. The reasons are that (a) I believe that the number of sellers, rather than their size distribution, is what determines whether all sellers will behave with reciprocal self-restraint, and (b) I am impressed by the fact that aggressiveness emerged with as few as three rivals in the experiments of Fouraker and Siegel [27].

Second, I excuse every merger that to any extent reduces costs. The reasons are that (a) I give efficiency in production high priority, (b) I am uncertain whether and by how much a merger will increase prices, (c) I think a price increase may improve resource allocation when prices elsewhere differ from marginal costs, and (d) as Williamson showed, even if we neglect the second-best qualification just mentioned, "If a reduction in average costs on the order of 5 to 10 percent is available through a merger, the merger must give rise to price increases in excess of 20 percent if [the price elasticity of demand] $\eta \cong 2$ and in excess of 40 percent if $\eta \cong \frac{1}{2}$, for the net allocative effects to be negative" [79, p. 23].

12. *Undesirable entry*: entry by a noninnovator when undue losses exist or when capacity or the number of sellers is larger than efficiency permits.

13. *Misinformation*: information that is less complete, reliable, or available than would maximize the expectation of a measure of traders' collective gain from trade in the market, net of information costs.

Information often costs little compared to its apparent value. Consider, for example, posted prices at gas stations and other drive-ins, centralized listings for real estate and jobs, market news for farm products, and, for packaged products, standards of identity, disclosure of hazards, specification of contents, grade labeling, and per-unit pricing.

"Perfect knowledge" often is regarded as ideal. This view overlooks certain implications and costs. Espionage, interlocking directorates, and pre-filing of price changes undermine aggressiveness. Product testing may be an unwarranted expense when quality deteriorates or when price and

quality already are perfectly correlated. The results of tests already made by governmental agencies, however, should obviously be disclosed.

14. *Inefficient rules of trading*: a set of rules that fails to maximize the expectation of the ratio between the actual value and the maximum value of a measure of traders' collective gain from trade in the market, net of transaction costs.

Why do the rules affect collective gain? Because central markets involve transshipment. Because haggling and auctions are time-consuming. Because descending-price auctions move faster than ascending-price auctions. Because, as Vickrey showed [74], sealed bidding fosters misallocation when the price a person bids determines both whether he buys and how much he pays. Because, as Chamberlin showed [12, Chap. 11], bazaars are conducive to extra-marginal sales and purchases. One illustration must suffice. In Santiago, Chile, a line of carts waits through the night for the vegetable auction to start. When it does start, lot-by-lot selling can detain large buyers for hours.

15. *Misregulation*: government action or inaction that fosters inefficiency. Examples of the former are the imposition of historical production quotas, defective grading systems, and out-of-state fees. Examples of the latter are the failure to grade vehicle tires, to inspect all meat, and to unitize oil production.

The foregoing list contains, I think, every verifiable market condition that I would regard as avoidable and undesirable. I would call a market *effectively competitive* if, and only if, it had none of these 25 characteristics.

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The Lockset Method of Sequential Programming Applied to Routing Delivery and Pickup Trucks

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The lockset method of sequential programming was used in this study to route feed delivery trucks and indicated potential distance savings of as much as 20 percent in comparison to the actual routes used by the business concerns. It was also found that in some cases the number of trucks required to make the deliveries could have been reduced from the number actually used, without changing the day of delivery. Feed manufacturing firms from New England to California supplied information on actual deliveries. An ex post routing of the same trucks to deliver the same quantities to the same receivers was made and the distance and number of trucks needed were compared with the distance and number of trucks actually used. Typical distance reductions were from 8 percent to 12 percent. In no case did the actual routing show fewer miles than the routes discovered by use of the lockset method. The system is computerized to enable a dispatcher to design delivery routes and issue loading instructions for each truck as soon as orders for a given day are known.

DELIVERY and pickup by truck is an important activity of many firms which deal with farmers. Practically all manufactured feed and commercial fertilizer are hauled by truck during some phase of distribution. Milk and produce are picked up at the farm and after processing are delivered to the store or to the consumer by truck.

Often trips involve servicing two or more stops where the sequence of stops is important in determining the length of the route. A principal factor affecting the cost of delivery is the distance traveled per unit of product delivered.¹ Thus, any procedure which will result in driving a shorter distance or spending less time en route while providing the same services can contribute to lower costs and improved marketing efficiency. The lockset method of truck route selection offers considerable promise of being such a procedure.²

When a single trip involves deliveries to more than one customer, the dispatcher must determine the exact sequence in which stops will be made. The customer sequence is important not only in determining the distance to be traveled but also in positioning the load in the truck so that orders can be unloaded efficiently.

The dispatcher faces a number of alternatives as he proceeds to schedule deliveries. The calculation of the distance for each possible route is

¹ For commercial feed manufacturers, for example, see Schruben and Clifton [6].

² The method developed here has roots in procedures proposed by Dantzig and Ramser [4] and by Clarke and Wright [2].

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impractical under most actual operating conditions. For example, the total number of possible routes for one vehicle through N points and returning to the origin is $\frac{1}{2} N!$ not counting the reverse of each route. A mere dozen stops linked in such manner will have nearly 240 million different route possibilities. One more stop added to this set would increase the number of possible route combinations by nearly 3 billion. According to Churchman, Ackoff, and Arnoff [1, p. 472], for 20 stops, a computer programming one sequence per microsecond and working 8 hours a day, 365 days a year, would take about 250,000 years to find a solution. The use of more than one vehicle from a single depot further complicates the situation.

The lockset method is not deterministic in the sense of offering mathematical proof of optimization. In the absence of such proof, it must be presumed that the possibility exists for a better solution than is provided by the lockset method. Thus, the method described here should be thought of as providing a feasible-rational rather than a feasible-optimum solution. It should be regarded as a tool to aid the dispatcher rather than as a substitute method to take his place.

Even though the solution should be thought of as feasible-rational, this has been tested against results of dispatching methods used by firms of different sizes, having different delivery configurations and different numbers and sizes of trucks. These firms operated under a wide variety of conditions from New England to California. In all, approximately 20 routings of 12 firms have been analyzed by the authors. In no case did management procedure result in a routing with fewer miles than was discoverable by an appropriate version of the lockset method.

Typically, distance savings varied from 3 to 12 percent, although in one case savings of as much as 20 percent were discovered. Furthermore, this firm used seven trucks, whereas the routes discovered by the lockset method would have required four trucks. Although the proposed routes may have been only feasible-rational in this case, they did suggest a major improvement over the management solution amounting to approximately \$200 in variable costs for the day tested plus the fixed costs of keeping three unneeded trucks.

The steps of the lockset method are demonstrated by describing the solution of two hypothetical problems. The first involves selecting a sequence of stops of a set which will constitute one route. The second is a multiple route problem which selects the stops to be incorporated into each route set and also determines the sequence of stops within each set. In addition, the results of an ex post analysis of an actual case are presented typical of those which we have discovered in our investigation of this problem.

The presumption is made that if a demonstrable optimum for a small problem can be selected by the suggested procedure, the optimum for a

large problem can also be selected by the same procedure, even though verification by calculating each combination is not practical.

Optimization is defined in this article as minimizing total travel distance. Distance in examples A and B is expressed as minutes required to traverse the route. In the case of multiple routing, the optimum is realized if the sum of the distances needed to complete all deliveries is a minimum. If total route time for the driver is a factor, the time spent unloading can be included. Other measures of distance may be used, such as miles, cost, and fuel used. (Distance was measured in miles in example C.)

Solutions of two hypothetical routing problems and one actual case are now presented to illustrate the application of the lockset method on two levels of complexity.

Example A

The most elementary routing problem is that of selecting the sequence of stops when the stops on that route are given. This is generally referred to in the literature as the *traveling salesman problem*. The only condition imposed is that a given set of delivery stops be joined by a route having the shortest distance.

In this example, a routeman is to leave the plant from which all deliveries originate, make stops at four customer locations, and then return to the plant.³ The problem is to serve this set of customers in a sequence that will minimize the time required for the trip. Thus, the customer set is fixed, and only the sequence of stops remains to be determined.

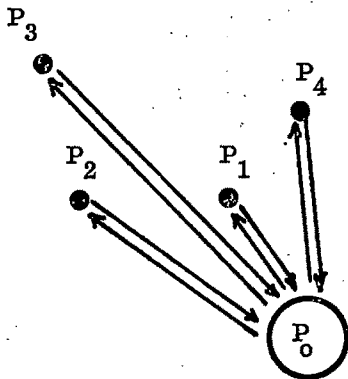
The distance measured in travel time between each pair of points is given in Table 1. For example, it takes 23 minutes to travel from customer 1 to customer 4. Only a half-matrix is necessary, since the distance between any two points is considered to be the same regardless of the direction traveled. In this example, there are but 10 possible pairs of points and 12 possible routes. For such a small problem, the shortest route can easily be verified by calculating distances for each possible route. This route is P-1-2-3-4-P.

Table 1. Distance in minutes for example A

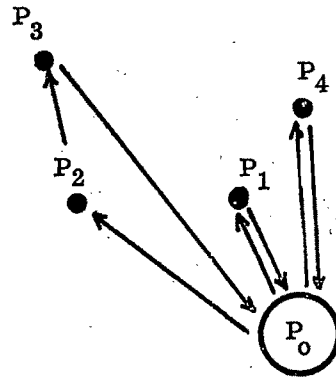
To \ From	Plant	Customer 1	Customer 2	Customer 3
	minutes travel time			
Customer 1	34			
Customer 2	47	17		
Customer 3	67	34	26	
Customer 4	48	23	34	31

³ The example is taken from Richard B. Maffei [5].

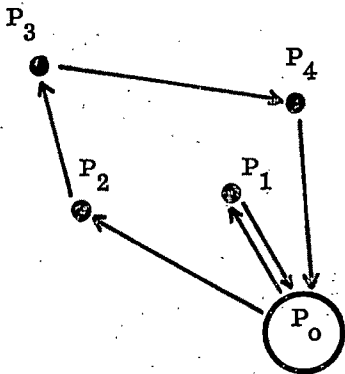
The lockset method assumes as an initial basis the distance that would be required if each delivery were to be made on a one-stop route. This assumption, which requires no computation or tableau, may be shown graphically where each stop is paired with the origin on a separate route, as indicated by diagram A of Figure 1. This would represent the maximum distance to service these customers. This initial implied basis is



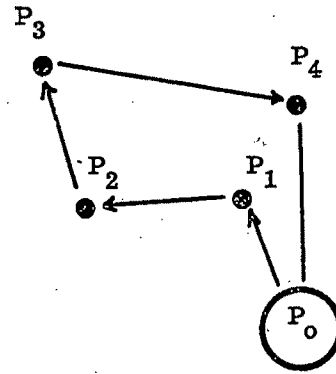
A. Initial tableau solution



B. First aggregation,
joining $P_2 P_3$



C. Second aggregation,
joining $P_3 P_4$



D. Third aggregation,
joining $P_1 P_2$

Figure 1. Successive stages of aggregation of stops to form the delivery route set, example A

modified by a succession of aggregations as indicated by the following steps.

The first step in the lockset method is to compile a list of all possible pairs of points not involving the plant (or origin), P_o . See Table 2, where P_1, P_2, P_3 , and P_4 represent the four delivery stops.

Table 2. Pairing list and distance-saved coefficient, example A

Pairing		Distance-saved coefficient			
P_i	P_j	$P_o P_i$	$P_o P_j$	$P_i P_j$	DSC
P_2 with P_1		47	34	17	64
P_3 with P_1		67	34	34	67
P_3 with P_2		67	47	26	88
P_4 with P_1		48	34	23	59
P_4 with P_2		48	47	34	61
P_4 with P_3		48	67	31	84

The second step is to compute the *DSC* (distance-saved coefficient) for each such pair. The *DSC* is used to determine the sequence to be followed in set aggregation. The sequence is in a descending order of the size of the *DSC*. The *DSC* is the distance to be saved by servicing P_i and P_j on the same route compared with the distance required to service each on a separate route.

The joining of stops to reduce total distance is illustrated in Figure 2.

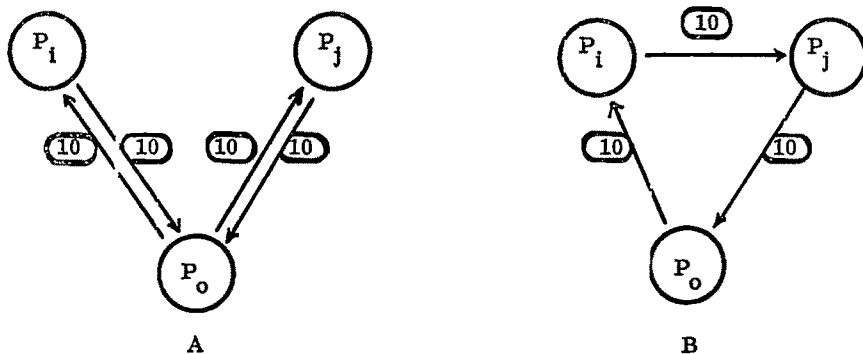


Figure 2. Distance saved by including P_i and P_j on the same route

In this example, a distance of 10 units is saved if P_i and P_j can be serviced on the same trip. The equation for computing the *DSC* is

$$P_o P_i + P_o P_j - P_i P_j = DSC$$

where

- P_o is the origin,
 P_i is the point i
 P_j is the point j ,
 P_oP_i represents distance between P_o and P_i ,
 P_oP_j represents distance between P_o and P_j , and
 P_iP_j represents distance between P_i and P_j .

The DSC computations for Example A are given in Table 2.

The third step is to consider joining the pair with the largest DSC on the same route. The first tentative pairing in this problem would combine P_2 and P_3 on the same route, $P_oP_2P_3P_o$ (or the reverse). If P_2P_3 can be successfully joined without intervening stops, the distance saved will be 88 minutes when compared with the distance required by the initial implied basis.

The next step is to test the revised route for feasibility. The tentative pairing must meet two tests:

- a) Each stop must have at least one leg connected with the origin.
- b) Each stop must previously have been on a different route.

Joining P_2P_3 on the same route without intervening stops is accepted because both tests are met. The P_2P_3 leg will be retained throughout subsequent aggregations; it is "locked in" the route set. This route now is $P_oP_2P_3P_o$, as indicated by diagram B of Figure 1.

The next step is to consider joining on a revised route the pair having the next largest DSC. In this problem, it is the pair P_3P_4 having a DSC of 84. Both of the above tests are met, and P_3P_4 becomes a part of the revised route, as shown in diagram C of Figure 1. The route now reads $P_oP_2P_3P_4P_o$.

Of the remaining pairs, P_1P_3 has the largest DSC, 67 minutes. This pair is the next to be considered. However, acceptance of this pairing is impossible without increasing the distance. P_3 is currently connected with P_2 and with P_4 . Condition *a* is not met. Hence, P_3P_1 will not be joined and this leg will not again be considered, as it is "locked out."

The remaining largest DSC is for P_1P_2 . Note that P_1 is still joined to P_o by two legs and to P_2 by one leg. Both tests are met and this joining is accepted. The revised route now reads $P_oP_1P_2P_3P_4P_o$ (or its reverse).

When there no longer are pairs to be tested, the optimum route has been identified. The optimum route is $P_oP_1P_2P_3P_4P_o$, which is the sequence identified when the distance for each possible route was calculated and compared. The lockset method discovered the optimum route by a simple procedure which did not necessitate the calculation of the distance for each possible route.

We have termed this procedure the "lockset method" because the leg connecting each pair, as it is considered in a logical sequence, either is

locked into a route set or is excluded from further consideration. Each such pairing is considered only once in the entire procedure. At each stage of aggregation, the leg connecting the points under consideration is either locked in or locked out of the set of distances comprising a route.

Example B

Solution of a multiple route problem is presented next. As in the first example, there is a central plant from which all deliveries originate. Specific quantities of the product have been ordered and are to be delivered to specific delivery points. Delivery points are too numerous to be combined on one trip. A period of time during which deliveries are to be made has been designated. The total quantity to be delivered during the period is too large to be loaded on one carrier. The number of carriers available for making deliveries, the capacity of each, and the maximum distance that each can travel are given.

The lockset method (*a*) selects the stops to be incorporated into each route set, (*b*) determines the sequence of stops within each route set, and (*c*) assigns a carrier to be used in servicing each route set.

This problem is solved when specific carriers are assigned to specific routes and the stops are in such sequence as to minimize the total distance for all routes.

The second example involves seven points, a central plant where deliveries originate (P_0) and six customer stops where deliveries are made ($P_1 \dots P_6$). The location of the plant and each of the six stops is shown in Figure 3. The distance from P_1 to P_2 is 56 minutes; from P_4 to P_5 is 85 minutes, etc. The distance between each pair of points is given in Table 3.

The delivery order list gives the quantity to be delivered to each stop during a given delivery period. A plant may service 300 customers, but on any given day may make deliveries to only a few. Some customers may require a daily delivery; others may require weekly or even less frequent delivery. For some firms, such as feed manufacturing, quantity requirements change from one delivery to another for any given customer. Rarely would any delivery route configuration be exactly the same as for the previous day.

The quantities (tons) to be delivered to each stop in Example B are as follows: to P_1 , 7; to P_2 , 6; to P_3 , 2; to P_4 , 15; to P_5 , 5; and to P_6 , 4.

The carriers available, the capacity of each carrier, and the maximum distance each can be driven are as follows: A, 9 tons, 175 minutes; B, 9 tons, 175 minutes; and C, 12 tons, 250 minutes. The capacity must be expressed in the same units as the delivery list: for example, in tons, bags, or hundredweights. The maximum distance restriction must be expressed in the same units as the matrix showing distances between points, that is, in time, miles, etc.

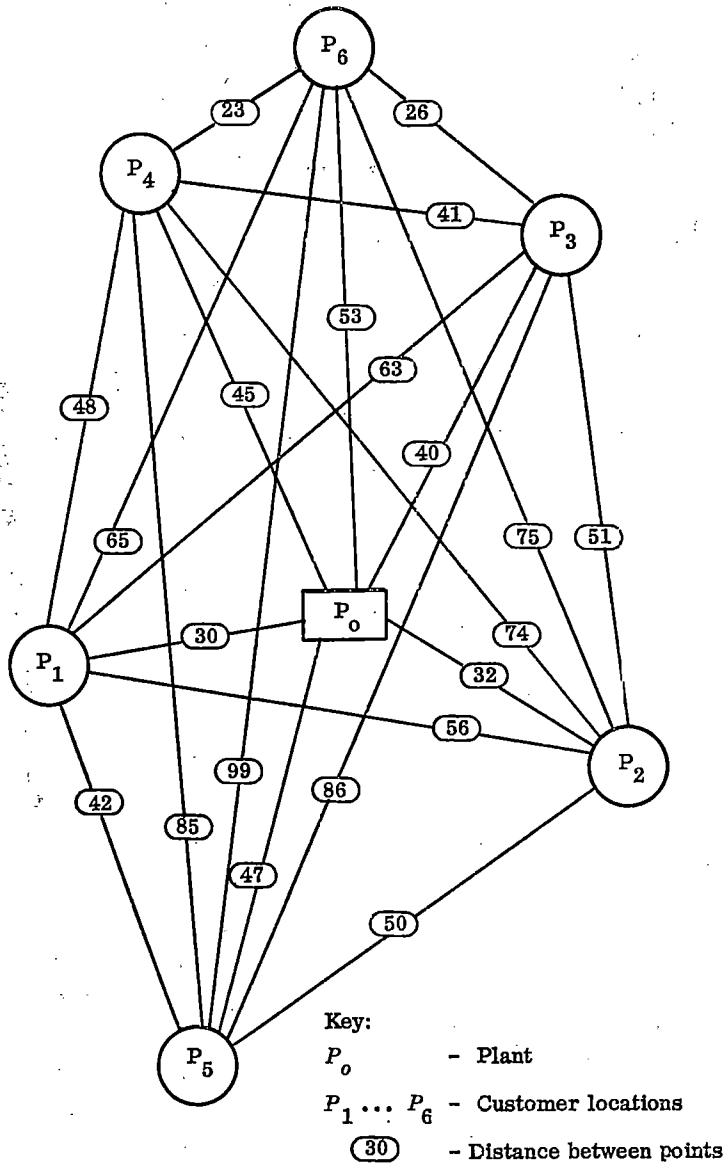


Figure 3. Location of points for example B

Capacity and distance restrictions are imposed by such things as the physical nature of the equipment and the work policy affecting drivers' hours.

The lockset procedures for solving the problem posed in Example B follow.

Table 3. Distance matrix for example B

From T _C	Plant	P ₁	P ₂	P ₃	P ₄	P ₅
		.....minutes travel time.....				
P ₁	30					
P ₂	32	56				
P ₃	40	63	51			
P ₄	45	48	74	41		
P ₅	47	42	50	86	85	
P ₆	53	65	75	26	23	99

The first step is to examine the delivery order list to see if any stops require a quantity equal to or greater than the capacity of the largest carrier. If so, the largest carrier is assigned to deliver a full load to those stops. A notation is made on the delivery list that the balance is to be delivered as a partial load on another route.

In this example, P_4 required a delivery of 15 tons. Carrier C can haul 12 tons and is assigned to make a one-stop trip to P_4 carrying a full load. This assignment is recorded as route 1 on line 1 in Table 4, which, when completed, will constitute the schedule of deliveries for the period. There remain 3 tons to be delivered to P_4 .

Table 4. Trip allocation, example B

Route number	To	Carrier	Capacity	Combined load	Distance
			.....tons.....		.....minutes.....
1	$P_4P_4P_0$	C	12	12	90
2	$P_5P_3P_6P_4P_0$	A	9	9	134
3	$P_5P_2P_0$	B	5	6	64
4	$P_5P_1P_5P_0$	C	12	12	119

Any other one-stop trips would be assigned in the same manner. Trips determined in this manner are not involved in the lockset procedure. The remaining quantities (tons) to be delivered to each stop are as follows: to P_1 , 7; to P_2 , 6; to P_3 , 2; to P_4 , 3; to P_5 , 5; and to P_6 , 4.

The second step is to compute the DSC for each pair of stops not connected with the origin. The previously outlined procedure is followed and the results are shown in Table 5.

The third step is to consider joining the pair having the largest DSC value, from Table 5. In the example, this pair is P_5 and P_4 , with a DSC of 75. This means a trip which goes from the origin to P_5 , then to P_4 , and then back to the origin; it will require 75 fewer minutes than if separate trips were to be made from the origin to each of the two stops as in the initial implied basis. The revised route would be $P_0P_4P_5P_0$.

Table 5. Pairing list and distance-saved coefficient, example B

Pairing		Distance-saved coefficient			
P_i	P_j	$P_o P_i$	$P_o P_j$	$P_i P_j$	DSC
P_2 with P_1		32	30	56	6
P_3 with P_1		40	30	63	7
P_3 with P_2		40	32	51	21
P_4 with P_1		45	30	48	27
P_4 with P_2		45	32	74	3
P_4 with P_3		45	40	41	44
P_5 with P_1		47	30	42	35
P_5 with P_2		47	32	50	29
P_5 with P_3		47	40	86	1
P_5 with P_4		47	45	85	7
P_6 with P_1		53	30	65	18
P_6 with P_2		53	32	75	10
P_6 with P_3		53	40	26	67
P_6 with P_4		53	45	23	75
P_6 with P_5		53	47	99	1

The fourth step is to test the revised route for feasibility. In Example B, four tests are required, the first two of which have been explained earlier. The four tests are as follows:

- Each stop must have at least one leg connected with the origin.
- Each stop must previously have been on a different route.
- A carrier of sufficient size must be available to carry the combined load.
- A carrier capable of traveling the required distance must be available.

Joining of P_4 and P_6 would meet all four tests. The smallest available carrier capable of carrying the load and traveling the distance is Carrier A, and it is tentatively assigned to this route. The route $P_o P_4 P_6 P_o$ (or its reverse) is accepted as a feasible route, and the leg joining P_4 and P_6 is locked into the route set. This set is identified as Route 2 in Table 4.

The next step is to select from the remaining pairs the one next to consider joining on the same route. The largest DSC of a pair not previously tested is for $P_6 P_3$, with a DSC of 67. This pair meets all four tests. Carrier A is capable of hauling the additional 2 tons required at P_3 and can travel the additional 26 minutes without exceeding the distance restriction. This leg is added to Route 2.

Route 2 now is $P_o P_4 P_6 P_3 P_o$. Note that P_6 no longer is connected by a leg to the origin. Its position in the set that will comprise Route 2 is locked between P_4 and P_3 . Regardless of possible later modifications, the carrier serving P_6 will arrive from P_4 and depart to P_3 (or the reverse).

The procedure is repeated until all pairs have been considered. As each succeeding pair is accepted or rejected, consideration is shifted to the remaining pair having the largest DSC. If the pair meets all four tests, it is

accepted; if not, it is rejected. When all pairs have been considered, the "feasible-rational" solution is identified and carriers have been assigned to each route.

The feasible-rational solution for Example B consists of four routes which are shown, together with carrier assignments, in Table 4. This table constitutes the delivery instructions for the period covered by the problem presented as Example B. When unloading and delay time is added, it can be used to predict time of arrival and departure of each truck at each stop.

It will be noted that the lockset procedure filled the carrier to capacity on three of the four trips. Trucks assigned by the lockset method tend to haul capacity or near-capacity loads. By inspection the dispatcher may wish to change carrier assignments. Carriers are not locked to routes—only the legs connecting points are locked.

Example C

This example is an ex post examination of a truck dispatching schedule used by a firm in delivering 90 tons of feed during one business day.

The procedure was to obtain a list and location of each customer serviced, the quantity delivered to each customer, the trucks used to make each delivery, the sequence of stops made by each truck, and the miles between the plant and each customer and between each pair of customers.

Thus, we knew how management actually delivered the feed (Table 6). We used the lockset method to discover an alternate solution (Table 7). There could have been a saving of 195 miles, and one less truck could have been used.

It should be noted that all of the information necessary to use the lockset method was available to management prior to the scheduling of the deliveries. The ex post solution, which saved 10 percent of the distance, could have been discovered at the time the management decision was made.

Conclusions

The lockset method of route selection will enable a dispatcher quickly to design delivery routes (1) by selecting a set of stops to be included on a given route, and (2) by finding a sequence for each set. The objective is to minimize the total distance traveled by all carriers; achieving this objective also tends to use the minimum number of carriers. Minimization is not subject to mathematical proof but results can be tested by comparing ex post routings with routings actually used by firms under operating conditions.

In an actual operation, we visualize the application of the lockset

Table 6. Management method of routing of feed delivery trucks, firm B-7, July 7

Trip number	Truck		Delivery stops	Distance ^m	Quantity delivered
	Number	Capacity			
1	1	<i>pounds</i> 36,000	<i>code</i>	<i>miles</i>	<i>pounds</i>
			Plant to 3	71	7,800
			7	82	2,300
			4	62	7,300
			2	28	4,700
			to plant	57	
				300	22,100
2	7	46,000	Plant to 14	206	20,230
			10	130	20,170
			to plant	159	
				495	40,400
3	3	45,000	Plant to 15	207	10,260
			11	21	33,980
			to plant	186	
				414	44,240
4	6	24,000	Plant to 5	94	19,720
			to plant	94	
				188	19,720
5	6	24,000	Plant to 16	57	16,360
			to plant	57	
				114	16,360
6	8	36,000	Plant to 8	144	7,500
			12	63	6,800
			13	64	10,000
			9	53	10,000
			6	19	1,290
			to plant	133	
				476	35,590
Total distance for all routes is				1,987	
Total delivery for all routes is					178,410

method as an aid to the dispatcher and not as his replacement. There are many considerations which a dispatcher can easily apply once he has before him a suggested solution.

Many restrictions can successfully be built into the algorithm. For example, assigning trucks with special equipment to delivery stops requiring its use, such as trucks equipped to deliver only bulk products to those customers who require delivery in bulk, can be a formal part of the proce-

Table 7. Lockset method of routing feed delivery trucks, firm B-7, July 7

Trip. number	Truck		Delivery stops	Distance	Quantity delivered
	Number	Capacity			
1	1	<i>pounds</i> 36,000	<i>code</i> Plant to 5 to plant	<i>miles</i> 94 94 <hr/> 188	<i>pounds</i> 19,720 <hr/> 19,720
2	8	36,000	Plant to 9 3 16 to plant	152 171 25 57 <hr/> 405	10,000 7,800 16,360 <hr/> 34,160
3	8	36,000	Plant to 4 10 8 to plant	82 84 32 144 <hr/> 342	7,300 20,170 7,500 <hr/> 34,970
4	7	46,000	Plant to 2 7 12 13 14 6 to plant	57 83 47 64 42 12 133 <hr/> 443	4,700 2,300 6,800 10,000 20,230 1,290 <hr/> 45,320
5	3	45,000	Plant to 11 15 to plant	186 21 207 <hr/> 414	33,980 10,260 <hr/> 44,240
Total distance for all routes is				1,792	
Total delivery for all routes is					178,410

dure. Other restrictions, such as length and width to fit certain customers' dock facilities or total weight to protect bridge load limits, may be considered. Cubic space, package counts, poundage, unloading time, and various combinations have been successfully used to measure size.

In our ex post examination of routes we have not encountered all of the constraints on any one route. In one case, cubic space may be important; in another, the trucks must be narrow to pass a narrow feedlot gate of an important customer; and in yet another, the time of day at which delivery is to be made is important as a customer service factor.

Although one computer program can be written to incorporate all con-

straints, it does not appear to be a practical solution at the present state of the art. This fact means that each user should take into account his special situation and make appropriate modifications to improve efficiency of the algorithm in his application. We are confident that further research will produce more sophisticated application procedures which will make it possible to delegate to a computer the important job of designing delivery routes.

There are many variations in delivery configurations both among firms and from day to day within a given firm. A computer routine has been refined by the authors for the solution of routing problems by the lockset method.⁴ The results provide the basis for comparison of routes actually used by commercial firms with routings that would have been selected by the lockset method. In general, the fewer the carriers and stops involved, the closer the actual routing to that discoverable by this method. In some cases, the distance was the same, but in no case from among the routings checked did the practicing dispatcher use a shorter route than that discoverable by this method.

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⁴ A computer program prepared by Harold M. Cochran and Frank A. Tillman was reported by Cochran [3].

Toward Effective Standardization of Hams*

J. G. KENDRICK AND J. B. HASSLER

Orderly marketing requires standardized products. Current USDA inspection criteria prevent the packer from completely standardizing cured hams on the basis of protein and moisture content. It is argued that changes in the current cured meat inspection procedures might result in (1) a more standardized product for consumers and (2) more accurate price signals for farmers, which could increase the reward to those swine producers whose product is of high quality. If the inspection criteria were changed so that cured hams could be standardized on the basis of a moisture-protein ratio of 3.79:1, a simultaneous equation model indicates that the gross live-weight price differential between swine producing high-protein hams and those producing low-protein hams could widen to \$2.42 per hundredweight.

INTELLIGENT economic decisions by consumers are frequently frustrated by heterogeneity within product classes. In a given grade, the task of standardizing agricultural products for retail sale is complicated, of course, by the heterogeneous nature of the raw material. The standardization of agricultural products is sometimes a complex process, but it is necessary for an efficient mass marketing system.

Our present public and private grading and standardization system generally promotes practices that result in uniformity of food items sold at the retail level. In a given brand of peaches, flour, processed peas, or apples, the consumer can expect minor variation between samples. Occasionally, laws, inspection procedures, or administrative practices evolve which partially restrict the production and marketing of a homogeneous product and in fact force some heterogeneity among products placed before the consumer. Such practices do not promote orderly marketing; on the contrary, they often result in confusion at the retail level and in the generation of incorrect price signals at the farm level of marketing.

This article focuses upon cured hams and the set of inspection procedures currently used for this product. Our analysis suggests that changes in the current inspection criteria would result in (1) a more standardized product for consumers and (2) more accurate price signals to farmers, which will increase the reward to those swine producers whose product is superior.

Processing Techniques and Standards

The procedures that meat processors follow in preparing green (fresh) hams for retail sale involves trimming and curing. In brief, this process

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entails (1) removal of none, some, or all of the bone, (2) removal of the skin and some of the exterior fat, (3) addition of curing salts in a water solution, and (4) smoking. The Processed Meat Inspection Division of the Consumer and Marketing Service, USDA, has established processing standards for hams. For the purpose of this article, the pertinent standards are that (1) the moisture content of the finished ham be no greater than 3.79 times the protein content and (2) the weight of the finished ham (ignoring the weight of any bone removed) be no greater than the weight of the green ham [3].¹

Regulations that protect the consumer from possibly deceptive practices and help him in the decision process are laudable. But regulations do not always fully accomplish their aims; further, regulations and inspection procedures may be improved. This is the crux of our argument—that changes in established procedures may provide more meaningful information to the consumer and, through the operation of the market place, provide more accurate price signals to the producer of the raw product—the farmers who produce swine.

The Critical Moisture-Protein Ratio

We assume that the presently used moisture-protein ratio is desirable. There are several possible explanations of the selection of the 3.79 to 1 ratio by the Meat Inspection Division: (1) the Meat Inspection Division may have drawn representative samples from the ham universe and determined that this ratio is representative, and thus based the performance standards on this universal mean; (2) experts in the preparation of hams for the palate may have determined that the ideal ham has moisture and protein in the stated ratio; or (3) studies may indicate that consumers prefer hams with moisture and protein in the stated ratio.

In any case, the regulatory agency has determined, through some procedure, that hams sold to consumers should have an established ratio of moisture to protein. If the ratio is important to consumers, then inspection procedures should insure that hams presented for retail sale be standardized to this ratio since the consumer is unable to ascertain precisely the moisture-protein relationship by visual inspection. In fact, if hams are not standardized on the basis of the moisture-protein relationship, then the consumer is unable to make meaningful price comparisons between hams or brands of hams [1].

If the meat processors were able to purchase standardized green hams, the processing task would be relatively simple. Unfortunately there is substantial variation among green hams in weight, protein content, moisture

¹ If the meat processor wishes to add water so that the weight of the finished ham exceeds that of the green ham, he may do so up to the limit of 110 percent. However, these hams must be marketed as "water added" hams and are not the subject of this article.

percentage, and the proportion of lean to fat.² Some green hams may be relatively heavy, moist, fat, and low in protein; others may be relatively light, dry, deficient in fat, and high in protein. There is a distribution of the protein percentage in any green ham weight and moisture class, because moisture and protein are not chemically bound together.

The Economic Problem

To the processor of green hams the economic problem is to evaluate market-generated price differentials among the various subclasses of green hams and determine which subclass or combination of subclasses will result in profit maximization. In the usual evaluation procedure, only a few variables and constraints are considered. Typically the variables are (1) purchase price, (2) selling price, (3) ratio of lean to fat, and (4) protein and moisture content of the lean and fat components. The constraints are (1) exterior fat covering on finished product, (2) ratio of moisture to protein, and (3) yield rate of the finished product with respect to original green weight.

The first constraint is determined by consumer acceptance. Some processors feel that hams with one-quarter of an inch of remaining exterior fat have the greatest eye-appeal. The second and third constraints are established by regulations issued by the Meat Inspection Division [3, 4]. Once again, if green hams were homogeneous, the procedures followed in the curing operation would result in a homogeneous product flowing to the retail market. However, given the heterogeneous nature of green hams, some must be dehydrated below the green weight to meet minimum chemical specification and some may require trimming of fat either to raise the relative protein level to established norms or to reduce the fat covering to consumer acceptance levels.

The conflict in the USDA-established constraints occurs as the processor attempts to standardize the finished product. Since green hams vary both in the ratio of moisture to protein and in the ratio of fat to lean, the processor can be faced with the following dilemma. A class of green hams may have high protein levels—with the ratio of moisture to protein considerably below the 3.79 requirement. If the processor removes the ham from the smoke house after injection of salt water so that the 3.79 ratio of moisture to protein is met exactly, he can still be in violation of USDA regulations since the finished product may exceed the weight of the green ham. The situation is different when the green hams have low protein levels. In this case, the processor may be required to dehydrate the green

² The "fat" and "lean" components of the hams are treated in this article in a different context from that used by a chemist. The fat component is the outside covering of the ham and contains, in addition to fat, water and some protein. In similar fashion, the lean component contains, in addition to protein, water and some fat. Of course, the protein and moisture content differ between the fat and lean components.

ham to meet the required moisture-protein ratio, with the result that the finished product weighs less than the green ham.

The processor must dehydrate some hams to meet the 3.79:1 ratio specification but may not be permitted to add moisture to others. The result is a product that is not standardized. Although all hams, under current inspection standards, will meet the minimum 3.79 to 1 ratio, some hams will exceed the standard—that is, contain a greater percentage of protein—because the processor is not permitted to have a processed ham yield greater than 100 percent of the green ham weight.

The processor presently has two alternatives open to him: (1) he can price the product as if it were homogeneous, or (2) he can try to establish differential pricing to reflect the varying protein content. In practice, of course, the cured ham is priced by weight—not protein—and thus the consumer is unable to make meaningful price comparisons. The consumer finds that Armour, Hormel, Swift, and other brands of ham are often the same price per pound, but perhaps are not the same price per unit for protein content [2]. Consumers who happen to choose a ham of higher-than-standard protein receive a bonus; those who happen to select a ham that just meets specifications are penalized. Farmers who produce hams with high protein do not receive the full differential price for their product because processors are not permitted to standardize these hams to the 3.79 to 1 ratio [6]. In essence, one inspection criterion—that processed hams may not weigh more than green hams—prohibits meat processors from standardizing processed hams at the minimum standard of moisture and protein.

If the yield constraints were removed from the USDA inspection procedures, we feel that two beneficial changes could occur in the long run: (1) at the retail level, cured hams could be standardized and priced according to the established percentage protein content, and (2) at the farm level, producers of leaner swine could be rewarded through the pricing mechanism. The remainder of this article is devoted to an analysis of a decision process which could be used by processors to establish the value of green hams and the probable long-run effects at the retail and farm levels of marketing if the yield constraints were removed for cured hams.

A Method of Standardization

Given a heterogeneous supply of green hams, some must be dehydrated to meet specification, some may have water added, and some may require substantial trimming of fat, which can be disposed of only at low salvage prices. Since the protein and moisture content are different in the lean and fat components of green hams, trimming of fat affects the ratio of moisture to protein and complicates the evaluation procedure.³

³ See footnote 2.

Simultaneous equations

One method that may be used to evaluate a given subset of green hams as well as to determine the amount of fat trim and shrinkage—or moisture to add—would be through a series of simultaneous equations of the form illustrated in Figure 1.⁴

Examples

Four hypothetical green ham subclasses were analyzed to demonstrate differing economic values among green hams. These are referred to as Cases 1–4. The composition of these subclasses is shown in Table 1.

Some of the values and classifications in Table 1 require further explanation. The data for these examples were drawn from the experience of a major packer, and because of the volume of hams processed in this plant, the data are assumed to be fairly representative of the relevant universe. Green hams representative of Cases 1 and 2 are grouped under the heading "Light hams"; those representative of Cases 3 and 4 are termed "Heavy hams." Under current marketing practices, green hams are divided into subclasses, with weight being the selection criterion and 16 pounds being the boundary between the two subclasses considered here. On average, lighter hams have less fat covering and higher levels of protein in the lean component than heavy hams. However, the two subclasses are very heterogeneous, and considerable overlapping occurs. Lighter hams are sold to the processor at about a two-cent-per-pound premium and resold by the processor for the same premium. The four cases presented in Table 1 represent green hams from the "tails" of each weight grouping but are not considered unusual examples.

The values for "Fat trim" (Item 10, Table 1) were computed from an equation. The experience of the packer suggests that if the value is calculated,

$$Y = -10.47 + 1.458 X,$$

where

Y is the ratio of fat trim (constant K_5 , Figure 1), and

X is the ratio of fat to total meat in the boned and skinned ham (Item 9, (Table 1),

then the result will be a remaining one-quarter inch of exterior fat covering on the processed ham.

A Case 1 green ham (see Table 1) is used in Figure 2 to illustrate the

⁴The equations are presented in a standard linear programming format, which provides automatic accounting of the gross margin. Because the number of variables exceeds the number of equations by one, in the final solution one of the water variables must be zero. The simplex process of linear programming automatically solves these types of simultaneous equations. A standard linear program was used in the solution, though the solution process ends at the point of feasibility.

Max: $-P_{GH}X_{GH} + P_{SF}X_{SF} + P_BX_B + OX_1 + P_{PH}X_{PH} + P_{SP}X_{SP} + OX_2 + OX_3 - P_{GH}X_D + P_{PH}X_W + OX_4 + P_{PE}X_S$										
Vector name:										
Buy ham	Sell skin	Sell bone	Fat trim	Sell ham	Sell trim	Fat	Lean	Dry	Add water	Cell salt
Subject to:										
(1) 1.00										= 1
(2) K_1			1.00							= 0
(3) K_2	1.00									= 0
(4) K_3		1.00								= 0
(5)				1.00						= 0
(6)					1.00					= 0
(7)						1.00				= 0
(8)							1.00			= 0
(9)								1.00		= 0
(10)									1.00	= 0
(11)										= 0

Figure 1. Simultaneous equations

Definition of variables:

 P_{GH} is the price per pound of green hams. P_{SF} is the disposal price of the trimmed skin and fat. P_B is the disposal price of the trimmed bone. P_{PH} is the price per pound of processed hams. K_1 is the quantity of ham for further processing as a ratio of green ham weight. K_2 is the skin trim as a ratio of green ham weight. K_3 is the bone trim as a ratio of green ham weight. K_4 is the quantity of ham for further processing as a ratio of K_1 . K_5 is the required lean trim as a ratio of K_1 . K_6 is the fat component as a ratio of K_1 . K_7 is the lean component as a ratio of K_1 . K_8 is the ratio of protein to the fat component. K_9 is the ratio of moisture to the fat component. K_{10} is the ratio of added salts to the processed ham. K_{11} is the ratio of protein to the lean component. K_{12} is the ratio of moisture to the lean component. X_1-X_4 are transfer and physical conversion vectors.

Table 1. Assumed green ham composition, disposition, and values, four cases

Item	Light hams		Heavy hams	
	Case 1	Case 2	Case 3	Case 4
	..... cents per pound			
1. Purchase price of green ham	50	50	48	48
2. Sale price of removed skin and trim fat	8	8	8	8
3. Sale price of removed bone	1	1	1	1
4. Sale price of processed hams with salts, internal bone, and water (if any) added	65	65	63	63
	..... ratio			
5. Ratio of removed skin to green ham weight	.05	.05	.05	.05
6. Ratio of removed bone to green ham weight	.07	.07	.07	.07
7. Ratio of weight of green ham ready for trim and processing to total green ham weight	.88	.88	.88	.88
8. Ratio of lean component to total weight of ham excluding internal bone	.75	.86	.70	.86
9. Ratio of fat component to total weight of ham excluding internal bone	.25	.14	.30	.14
10. Ratio of fat trim to weight after removal of skin and two bones	.1598	.0434	.2127	.0434
11. Ratio of internal bone to ham weight after fat trim	.077	.077	.077	.077
12. Ratio of moisture to the lean component	.693	.65	.693	.693
13. Ratio of moisture to the fat component	.153	.153	.153	.153
14. Ratio of protein to the lean component	.198	.21	.16	.198
15. Ratio of protein to the fat component	.036	.036	.036	.036
16. Ratio of salt in processed ham to processed ham weight	0.022	0.022	0.022	0.022

computation of the matrix coefficients. Solutions were obtained for each of the four cases and the results are listed in Table 2.

Solutions

In the four cases considered, the gross margin per pound of green ham varies from 13.3 cents (Case 2) to a loss of 4 cents (Case 3)—a range of 17+ cents. This wide variance in ham margins depends primarily upon the amount of water that is added (0.1 + pounds in Case 2) or the water that must be subtracted (0.5 + pounds in Case 3) so that the finished hams are standardized at a moisture-protein ratio of 3.79 to 1. Obviously the lower fat-higher protein green hams are more valuable to the processor. The gross margins for the Case 1 hams (2.9 cents) and Case 4 hams (9.4 cents) illustrate the overlapping in economic value that occurs between the light and heavy classes of green hams. Of course the costs associated with the processing (allocated fixed costs and the variable costs of boning, trimming, curing, and packaging) would be subtracted from the solution values of gross margins to determine the net margins. These costs are thought to be a constant value per pound. Thus, while the absolute

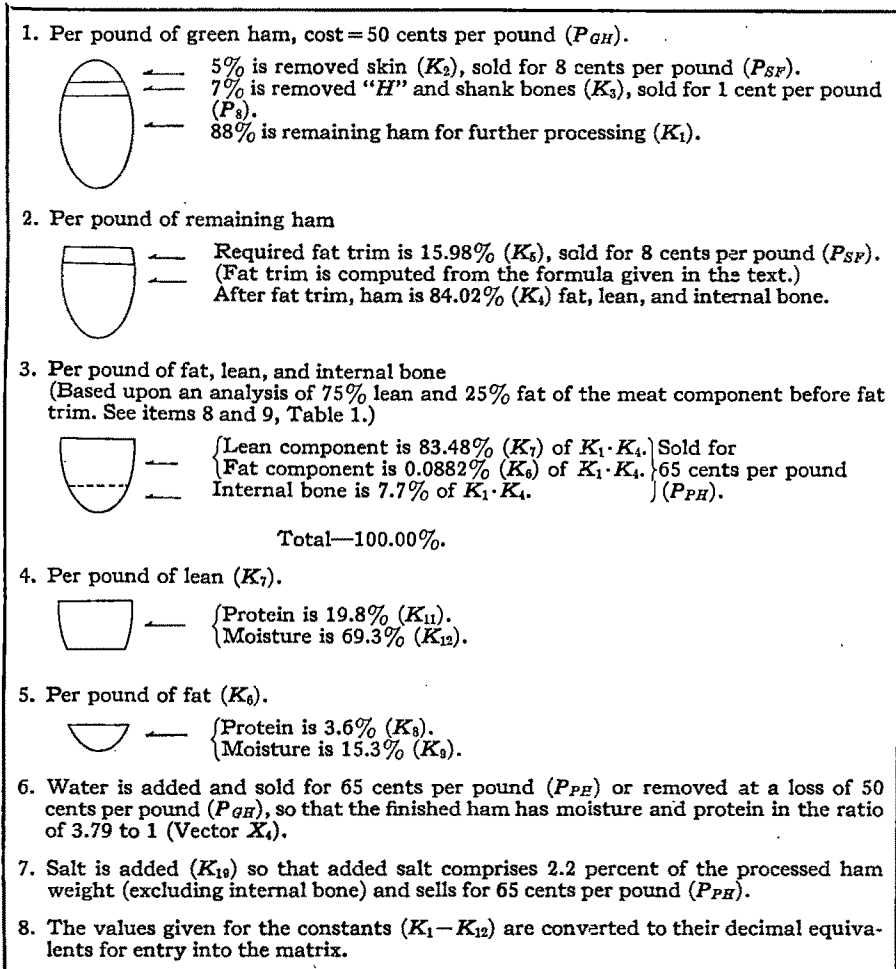


Figure 2. Composition, disposition, and computation of matrix coefficients for a Case 1 green ham

Source: Table 1.

Table 2. Solution values in terms of a pound of green ham, four cases

Case	Re-moved skin & bone	Fat trimmed	Meat and bone in finished product	Water added or subtracted	Added salts	Weight of processed ham	Total weight of salable products	Green ham gross margin	Water-protein ratio	
									Green	Pro-cessed
				lbs.				dollars		
1	0.12	0.14062	0.73938	0.03436	0.01577	0.78951	1.05013	0.02913	3.54:1	3.79:1
2	0.12	0.03819	0.84181	0.10103	0.01932	0.96216	1.12035	0.13315	3.13:1	3.79:1
3	0.12	0.18718	0.69282	0.05112	0.01294	0.65464	0.96182	0.04023	4.32:1	3.79:1
4	0.12	0.03819	0.84181	0.03900	0.01795	0.89876	1.05695	0.09397	3.53:1	3.79:1

net margins would be reduced, the range of 17+ cents per pound between the ham classes would still exist.

Effects of Standardization

Recognizing the pitfalls inherent in sweeping generalizations, we still believe that, if the restriction prohibiting the processed weight from exceeding the green weight were rescinded, the processor would reap greater short-run profits by concentrating upon the subclass of green hams typified in Case 2 (relatively low fat and high protein). As noted previously, the present marketing system differentiates green and processes hams only on the basis of weight. Again, if the yield restriction were removed, there would be powerful economic incentives for processors to purchase green hams on a basis other than weight—enough incentive that new technology for grading hams might soon be developed. In fact, the sorting of green ham subclasses could be greatly improved without waiting for a technological breakthrough. The trained human eye can, in a gross fashion, sort green hams for fat covering and protein content—the darker the pink, the higher the protein percentage.

Sharing the economic gains

It is interesting to speculate as to the possible short-, medium-, and long-run effects of a change in inspection requirements. In the short run, processors who developed methods of assessing the economic differences in green ham subclasses would retain most of the increased profits. In the medium run, suppliers of green hams would be able to command a premium price for subclasses with relatively high levels of protein and low fat covering. One would expect that, however imperfect the sorting procedure, greater price differentials between lean and fat swine would emerge at the farm level of marketing.

In the long run, if it proved profitable to develop a technology for accurately differentiating green hams, the widespread use of the illustrated computational procedure would equate processor gross margins among the various subclasses of green hams. The processor would then be indifferent as to the subclass of green hams purchased for processing. If the processor, in the equilibrium state, were indifferent, then the imputed price differentials on hams would be effected in the market and reflected backwards to the swine producers. Assuming that hams would be sold to consumers as a homogeneous product, we give in Table 3 the magnitude of the gross price differentials⁵ that might develop in the live hog market [5, 6].

⁵ No provision has been made for the costs of sorting green hams on the basis of protein. Estimating the cost of an undeveloped technology is hazardous. But cursory examination of the required technological development suggests that (1) the

Table 3. Current and expected gross price differentials between and among swine weight classes

Value and gross price differentials	Swine producing light-weight hams		Swine producing heavy-weight hams	
	Case 1	Case 2	Case 3	Case 4
	cents			
Gross margins for standardized hams ^a	2.913	13.315	— 4.023	9.397
Gross margins for standardized hams using Case 4 hams as the base	— 6.484	3.918	— 13.420	0
Current price differentials for live animals per cwt. ^b	50.000	50.000	0	0
Expected gross price ^c differentials for live animals per cwt. (considering only ham value differences)	—90.770	54.800	—138.000	0

^a Solution values as shown in Table 2.

^b Using swine above 240 pounds as the base.

^c Using Case 4 as the base, and assuming that hams represent 14 percent of live weight, we calculate the price differential per hundredweight as 14 (difference between Case 4 gross margin and other case). For Case 3 the computation is $14(-13.42) = -\$1.88$.

Within the lighter live-weight subclass, the expected gross price differential would be \$1.45 per hundredweight—current marketing practices do not differentiate among hogs that produce hams of the type found in Cases 1 and 2. Between the live-weight classes of swine producing light and heavy hams, the gross price differentials could widen by \$2.42 between swine classes that produce green hams typical of Cases 2 and 3.

Implications for Further Research

A possible gross live-weight differential of \$2.42 per hundredweight between swine classes would seem enough of an economic justification for changing present marketing and processing practices. As we have repeatedly indicated, under existing inspection standards, hams cannot be completely standardized for protein content. Thus, meat processors see little economic incentive to develop or demand a sorting procedure that will eventually provide greater rewards to those swine producers who market high-protein hams.

We should emphasize that inspection standards, being temporal, can be subjected to review and suggestions made for improvement. This has been our purpose. But before the changes that we have suggested are implemented, the following areas should receive attention:

1. A system of delayed payment to swine producers would have to be established. One possibility might be a partial payment at the time of sale

problem at hand is relatively simple and a solution might be possible at reasonable cost, and (2) if the suggested changes in inspection practices are adopted, the economic rewards are such that the development of such technology is highly probable.

of the live hog, followed by another payment determined after the ham component is evaluated. Similar systems have proved workable in milk and many of the specialty crops, such as walnuts, peaches, oranges, and cherries.

2. The question of what should be the appropriate ratio of moisture to protein in processed hams should be considered. In this article we have used the current standard of 3.79 to 1. Perhaps this ratio should be changed if supportive evidence can be developed. But the same general problem of standardization will still exist, no matter what standard is established.

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The Effect of a Marketing Order on Winter Carrot Prices*

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Marketing orders are utilized for the express purpose of improving returns to growers. Higher quality requirements and supply or rate-of-flow management are the major tools in such an effort. The adoption of the marketing order for South Texas carrots permitted a limited test of the hypothesis that derived demand would increase during the order period. The hypothesis is reasonable because of the relatively low quality image of Texas winter carrots. It appears that demand at the grower level in Texas did increase during the order period whereas demand at the f.o.b. levels in Texas and the major competing production area, California, remained unaffected. In effect, the spread between grower price and f.o.b. price narrowed in Texas. If most of the increase in demand was due to improved quality, total returns to growers probably increased as a result of the culling-price relation.

WINTER carrot production, which constitutes one-third of the total annual carrot production in the United States, is divided about 70:30 between Texas and California growers. Carrots from the two production areas compete in several markets throughout the country. Variable and relatively low prices and crop values led Texas growers to vote for a federal marketing order for winter carrots which became effective for 51 South Texas counties commencing with the 1960-61 season. The adoption of the marketing order presented an opportunity to examine its effect on the level of the prices received by winter carrot growers.

One hypothesis is that the derived demand for Texas winter carrots shifted upward and to the left during the order period, 1961-1966, relative to the preorder period, 1954-1960. The hypothesized upward-leftward shift in the derived demand function for Texas (Fig. 1) would have been due largely to the introduction of uniform grade and size standards in Texas, which simultaneously improved quality and, to some extent, reduced the volume shipped each season.

Texas prices were examined at both the f.o.b. shipping point and grower levels. Derived demand at the in-field or grower price level may have shifted upward because of stricter field grading associated with the marketing order's grade and size requirements and the general informational effects of the order, that is, information on prices, packing costs, volume of shipments, and allocation of shipments. At the grower level none of the costs of the order to shippers are apparent. Derived demand at the f.o.b. shipping point level may have increased as a result of more

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rigorous grade and size standards. Furthermore, it is possible that the spread between these two pricing levels in Texas—grower and shipper—was altered because of increased field grading before purchase by shippers and/or because of improved market information at the grower level.

Since Texas and California are competing winter carrot production areas, the possible effect of the Texas marketing order on California's price situation is of interest. In the usual case of two substitute commodities, other things being equal, an increase in the price of one commodity will increase the demand for the other. This competitive relation between Texas and California carrots is evident from the price equations discussed later, for the cross-price flexibilities are negative. It is believed that the advent of the marketing order made the Texas carrots more nearly comparable in quality to the California carrots, raising the average price of Texas winter carrots and narrowing the differential between the two areas (Fig. 1). The increase in the derived demand for Texas carrots would, theoretically, reduce the demand for California carrots. At given quantities, Texas prices increased, approaching the generally higher prices paid for California carrots as indicated by terminal market prices, because Texas carrots became less differentiated from California carrots throughout the duration of the Texas marketing order. Thus, a second hypothesis was that the derived demand faced by growers in California was reduced.

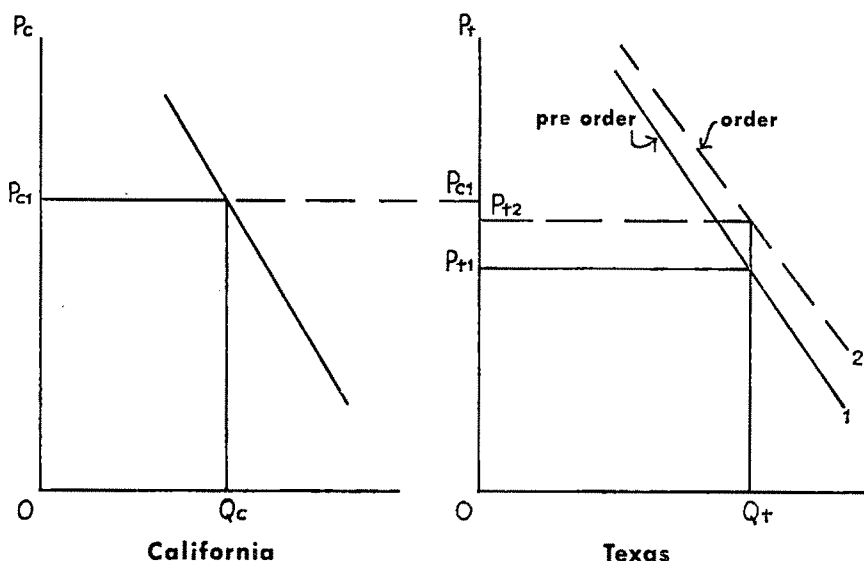


Figure 1. Hypothesized shift in the derived demand for Texas winter carrots due to the marketing order and relation to California derived demand

The derived-demand-relation hypothesis at the grower level in Texas is obviously rather gross in that it does not differentiate among the possible effects of any of the several market-organizing features of an order. The initial industry interest leading to the order, the decision-making responsibilities of the order committee, and the absolute increase in market information are all potential contributors to the reduction of market imperfections within a supply area. However, the grade, size, and container requirements associated with the Texas order related directly to the quality of the commodity marketed and provided most of the support for the derived-demand-relation hypothesis. Townsend-Zellner suggested this hypothesis, among others, in an article on marketing orders and market development [5, p. 1362].

Procedure

Interest was centered on changes in the derived demand relations for (a) Texas winter carrots as affected largely by improved quality and (b) California as a competing supply area. Since several variables were involved during the time period considered—production in both Texas and California, population, income, the general price level, and supplies of competing commodities—least-squares regression utilizing dummy variables for the marketing-order seasons was selected as an appropriate technique.¹

Data

The South Texas winter carrot marketing order was voted out in April 1966, partly as a result of allegedly discriminatory size standards, giving six years of experience under the order. The Statistical Reporting Service recorded prices for Texas winter carrots on an in-field basis through 1964, changing to an f.o.b. basis from 1964 to date.² Because Texas f.o.b. price data are available only from 1954 on, and in-field price data after 1964 are unavailable, the analysis covers the time period 1954–1964, which includes seven seasons without the marketing order and four with it (Table 1).

¹Logan and Boles used zero-one variables to allow for changes in intercept values of quarterly retail price equations for meats [2]. Tomek has discussed the use of zero-one variables in some detail in this journal [4] and he and Ben-David have provided a useful reference which illustrated the use of dummy variables in allowing for changes in both intercept and slope coefficients [1].

²After the change in price reporting from an in-field to an f.o.b. basis, the Statistical Reporting Service published a set of "revised Texas f.o.b. prices" for 1954–1963. California prices were reported as f.o.b. to the grower throughout the period of the analysis, presumably because of the California marketing system, and consequently California prices were considerably higher than the Texas in-field prices, which do not include packing charges. California prices were comparable to the Texas f.o.b. prices.

Table 1. Data used in winter carrot regression analysis, 1954-1964^a

Year	Price of carrots			Production of carrots per capita—U.S.		Disposable income per capita—U.S.
	Texas		California			
	in-field	f.o.b.	f.o.b.	Texas	California	
	<i>dollars per hundredweight</i>			<i>.....pounds.....</i>		<i>dollars</i>
1954	2.03	5.66	5.40	1.638	1.009	1,693
1955	1.45	4.89	4.23	1.874	0.993	1,786
1956	1.33	4.74	4.05	2.247	0.913	1,841
1957	0.99	4.28	3.36	1.798	1.025	1,838
1958	1.56	4.10	4.77	2.412	0.852	1,818
1959	1.38	4.34	4.30	1.575	1.233	1,877
1960	0.58	2.77	3.10	3.002	0.965	1,879
1961	2.13	5.26	5.70	1.760	0.797	1,903
1962	1.66	3.98	4.68	1.878	0.926	1,958
1963	0.81	2.97	2.77	2.450	1.085	2,002
1964	1.00	3.22	4.06	2.305	0.853	2,103

^a All prices and income deflated by the Consumer Price Index (1957-1959 = 100).

Source: USDA [6; 7, pp. 52-53; 8, pp. 86-91; 9; 10, p. 4].

Variables

The variables used in the regression analysis for Texas and California prices are as follows:

P_{ti} is the season average in-field price in dollars per hundredweight received by Texas growers, deflated by the Consumer Price Index.

P_{tf} is the season average f.o.b. price in dollars per hundredweight for Texas shipping points, deflated by the Consumer Price Index.

P_c is the season average f.o.b. price in dollars per hundredweight received by California growers, deflated by the Consumer Price Index.

X_0 is a dummy variable which is zero during 1954-1960 and one during 1961-1964.

X_1 is the total winter carrot production in Texas divided by U.S. resident population.³

X_2 is the total winter carrot production in California divided by U.S. resident population.

X_3 is the disposable personal income per capita in the United States, deflated by the Consumer Price Index.

Regression Analysis

The equations specified for both Texas and California prices were of the form:

³ Production was used as the supply variable in that total quantity available was believed to determine in-field and f.o.b. prices to a greater extent than would the amounts actually shipped.

$$P = f(X_0, X_1, X_2, X_3),$$

where X_0 is a zero-one variable which allows for changes in the level of net prices of winter carrots in Texas and California between the preorder period 1954-1960 and the order period 1961-1964. The influence of the general price level was adjusted for by deflating the price and income variables by the Consumer Price Index (1957-1959 = 100). An index of total vegetable production was incorporated as an additional shift variable at an earlier stage of analysis but was eliminated for lack of statistical significance. The estimated coefficients for the regression equations used are presented in Table 2.⁴

Table 2. Regression results for winter carrots, 1954-1964

Equation	Dependent variable	Constant	Regression coefficients ^a				R^2	Durbin-Watson statistic ^b
			X_0	X_1	X_2	X_3		
(1)	P_{ti}	9.9771	0.5064 (1.69)	-0.6364 (2.92)	-1.5169 (2.10)	-0.0032 (2.35)	0.86	2.42
(2)	P_{ti}	18.8898	0.1242 (0.31)	-1.4294 (4.94)	-2.5759 (2.70)	-0.0049 (2.73)	0.93	2.77
(3)	P_c	17.3264	0.4099 (0.54)	-1.2696 (2.33)	-4.1744 (2.31)	-0.0035 (1.02)	0.76	1.83

^a Regression coefficient divided by standard error given in parentheses.

^b Each of these is inconclusive regarding serial correlation.

Texas in-field prices

The coefficient of X_0 in equation (1) is statistically significant at the 10-percent level with the use of a one-tailed test, implying that the derived demand function during the order period was about 50 cents higher than that of the nonorder period, an increase of about 40 percent at the production-per-capita means (Fig. 2).⁵ In addition to the order variable, X_0 , the effects of Texas production and California production on Texas price are as expected, with both coefficients having negative signs. Increases in income have apparently been associated with a declining demand for fresh carrots during the period studied.

Texas f.o.b. prices

When Texas f.o.b. prices were used as the dependent variable, with the same independent variables as used with in-field price, an "order effect"

⁴ All specifications of the equation were solved by ordinary least squares. It is possible that California winter carrot production and Texas prices were jointly determined, but this possibility was rejected in favor of the assumption of predetermined production in the case of both Texas and California. A two-stage least-squares formulation of the problem resulted in similar estimates.

⁵ One-tailed tests were used with the zero-one variable and the two production variables where positive and negative signs, respectively, were expected.

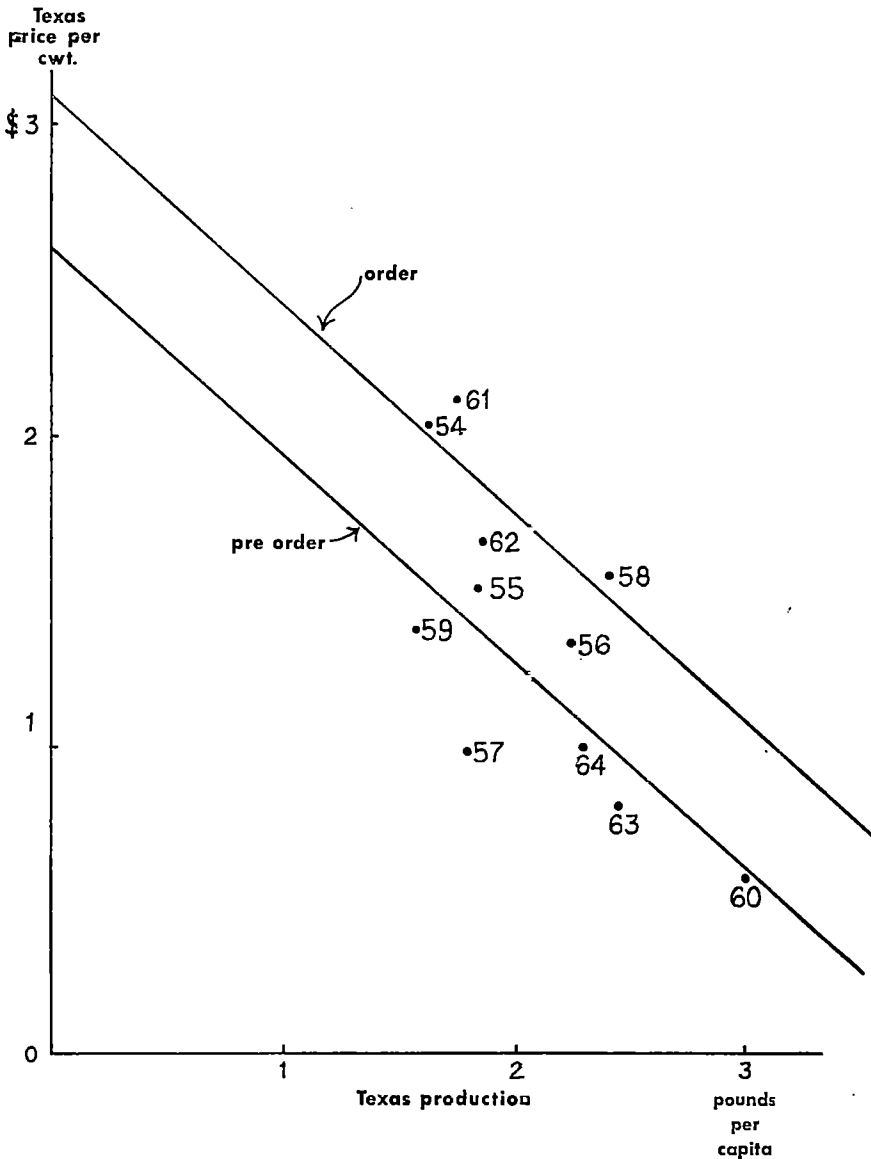


Figure 2. Derived demand functions for preorder and order periods at in-field price level, Texas winter carrots, 1954-1964

coefficient of 0.12 was obtained in contrast to that of 0.50 at the in-field price level (Table 2). However, the one-tailed *t*-test implies that chances are 4 out of 10 that such a value could occur as a result of random causes,

suggesting that the shift hypothesis should not be accepted at the f.o.b. level. The other coefficients and signs were as expected.

Spread between Texas in-field and f.o.b. price

Using the hypothesis that there may have been a shift in derived demand at the in-field or grower level but not at the f.o.b. level in Texas, we fitted an equation for the spread between these two price levels:

$$S = 4.256 - 0.0549X_1 - 0.4955X_2 \quad (R^2 = 0.58)$$

(2.35) (1.89)

where

S is the difference between Texas f.o.b. and in-field prices in dollars per hundredweight, 1954–1964,

X_1 is the Texas winter carrot shipments per season in carlot equivalents divided by one hundred, and

X_2 equals zero during 1954–1960 and one during 1961–1964.

The results for this equation suggest that (a) as would be expected, the season average price spread declined as the volume shipped per season increased, and (b) the spread declined by about 49 cents per hundredweight during the order period—roughly approximating the suggested upward shift in derived demand at the grower level indicated in equation (1) of Table 2. The shift coefficient, -0.4955 , in the spread equation is significant at the 10-percent level, as was that in the in-field equation. These “order effect” coefficients allow us to draw the tentative inference that the marketing order resulted in an upward shift in the derived demand at the grower level, narrowing the spread between f.o.b. and in-field prices, with little if any effect reflected at the f.o.b. level. If this did in fact occur, increased field grading and improved marketing information at the grower level are possible explanations.

California prices

The specification for California prices, equation (3) of Table 2, yielded a positive zero-one coefficient statistically significant only at the 30-percent level—that is, there were 3 chances out of 10 that it was due to random causes. The inference here, as for the Texas f.o.b. equation, would be that the derived demand at the f.o.b. level in California did not increase significantly during the order period. Since there was apparently no increase in the derived demand at the Texas f.o.b. level, there is no reason to expect the California derived demand at this level to have been affected.

Conclusions

On the assumption that all of the relevant shift variables have been included, the hypothesis that the derived demand relation experienced by Texas winter carrot growers shifted upward with the advent of the South Texas carrot marketing order during the four seasons, 1961-1964, would not be rejected on the basis of statistical significance at the 10-percent level. The f.o.b. derived demand relations for California and Texas winter carrots did not appear to shift significantly during the period of the marketing order in Texas. Rather, a narrowing of the spread between in-field and f.o.b. prices in Texas was implied.

Even if the quality and market-organizing effects of the federal marketing order in Texas did improve the relative price position of winter carrot growers in Texas during the 1961-1964 period, the implied higher prices are not necessarily indicative of increased net income to Texas growers. This conclusion is due to the fact that there was a reduction in the ratio of sales to production during marketing-order years because of the more stringent grade and size requirements. Hence, the specification of the hypothesis is an upward and leftward shift of the derived demand for Texas winter carrots: upward because of improved commodity quality and increased market knowledge at the grower level, and leftward because of the volume-reducing features of the more restrictive grade and size standards. The latter or volume effect is essentially a movement along with the higher demand relation.

Whether growers' net income increased for a crop of a given size during the order period depends on the "elasticity of quality" or the increase in price associated with the removal of low quality product [3, p. 624]. Unfortunately, the sales data necessary to compute ratios of sales to production at the grower level are not available. However, since the net price flexibility for Texas production on Texas price was close to unity, it is probable that the culling-price relation for Texas was inelastic and that net returns to Texas growers did show a relative increase during the order period.

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Price Elasticity of the Demand for Cigarettes in the United States

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The retail price elasticity of demand for cigarettes is a particularly important parameter for social decisions at this time. Results from prior cigarette elasticity studies vary widely, ranging from -0.10 to -1.48 . Temporal changes may explain some of this variation, but differences in research methods are more important. The quasi-experimental approach used in this article yields an elasticity estimate (-0.511) free of many of the extraneous and irrelevant systematic influences that afflict time-series and cross-section methods. In addition, the length of run of the elasticity is known and explicit. The method provides built-in protections against bias from trends in collinear variables and produces sensible estimates with reasonably small and measurable dispersion.

THE retail price elasticity of demand for cigarettes is a particularly important parameter for social decisions at this time. It is the overwhelming consensus among scientists that cigarette smoking increases mortality.¹ And price increases are a possible sanction that the government might use to decrease cigarette use.

Several studies of this elasticity have been done previously [1, 2, 4, 5, 9, 12]. Our main reason for delving again into the matter is that the previous estimates differ rather widely, ranging from -0.10 to -1.48 . Change over the course of time may explain some of the variation, but differences in method are more important, especially the difference between time series and cross sections.²

Study of the demand for cigarettes also provides another opportunity for trying out the "quasi-experimental" method in economics, and this study has led to further development of the method. Under this procedure, we estimated the arc elasticity of demand from the sales before and after a tax change in a state. These sales were standardized for secular changes in cigarette consumption in other states where price was unchanged. The method is therefore free of many of the extraneous and irrelevant systematic influences that afflict time series and cross sections. The method was used earlier to estimate the price elasticity of liquor [6], and cigarette consumption offers a particularly good chance to test further the usefulness and accuracy of the method.

¹ The Surgeon General's Committee *unanimously* agreed to use the term "causal" for the smoking-mortality relationship [11].

² The most elastic estimate was from the cross-section study [2]. This is what one would expect, assuming that the year-to-year correlation in cigarette prices among states is extremely high and that the price of cigarettes has at least some lagged effect

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As with liquor, the quasi-experimental method is especially appropriate for cigarettes because retail price changes are very infrequent. Infrequency of change is helpful for this quasi-experimental method and damaging to time-series analysis. Also, the length of run of the computed elasticity is known and explicit, unlike time-series and cross-section estimates, for which the lengths of run are "short" and "long," respectively, but un-specifiable in either case. This property is useful to policy makers who contemplate price alterations. Still another relevant property of the method is that it controls for forces such as culture, religion, international tension, and other influences which might bias time-series estimates. One possible drawback of the method is that there might be "leakage" across state borders in response to price differentials, but this effect was observed not to be important in the case of liquor, and hence we think it safe to disregard it here.

For each tax-change "trial" or "experiment," we computed an arc elasticity,

$$e_p = \frac{\frac{Q_2 - Q_1}{Q_1} - \sum_{i=1}^N \left(\frac{Q_4 - Q_3}{Q_3} \right) / N}{\frac{P_2 - P_1}{P_1}},$$

where

e_p is the price elasticity,

Q_1 is the consumption for the year (January to December) ended before price change in the trial state,

Q_2 is the consumption for the year (January to December) beginning after price change in the trial state,

Q_3 is the consumption for the year (January to December) before price change in the comparison states, for example, all states in which price was unchanged during the relevant period,

Q_4 is the consumption for the year (January to December) after price change in the comparison states,

P_1 is the price for the year before change,

P_2 is the price for the year after change, and

N is the number of comparison states.

The resulting estimates of price elasticity refer to the response in a defined period of time, in this case the year from 6 to 18 months after the

on consumption; the rationale is that a simple cross-section estimate sums up much of the effect of past as well as present price influence. Short time series, such as those used in some of the studies [1, 4, 5, 9, 12], are less likely to cumulate lagged influence into the estimate because of the relatively low serial correlation; hence, they produce smaller elasticities. The logic underlying the remarks in this footnote is worked out in Simon and Aigner [8].

price change. It is implicitly assumed that no other price changes occur in the state between the price change being studied and the measurement period. If the observed elasticity is, say, -0.50 , and a price change of 10 percent occurs, consumption will be 5 percent less than it would otherwise be during the 12-month period beginning six months after the price change. Estimates of state retail prices and per capita consumption in the years before and after the tax changes were taken from data published by the Tobacco Tax Council [10, pp. 61-111]. These data are obtained annually by means of a sample survey conducted in all states which impose cigarette taxes. These price terms are a weighted average retail price per pack, with both the form of sale (over the counter, single pack price, carton lot price, and vending machine price) and the types of cigarettes sold (regular size, king size, and filter tip) being taken into consideration. It seems fair to conclude that this survey produces reasonable state price estimates, since the price of cigarettes is much the same throughout a state. Substantial price differentials are normally found only by comparing states and are due primarily to the variation in state tax schedules.

The denominators in each ratio on the right-hand side of the equation are "before" quantities, despite the fact that some writers advise using the midpoint of the before and after values. Our reasoning is that when in policy discussions people ask, "What percentage change in consumption will a price change of x percent cause?" they mean, "What proportion of the existing level of consumption will the future level be?" Such a question calls for an answer derived from an elasticity formula with the existing level in the denominator, such as is used here. But this discussion may be moot, because the differences between estimates derived from the two formulas are quite small.

The individual estimates for each "trial" are shown in Table 1. The median estimate is -0.511 . We think that the median is a more sensible central-value estimate than the mean in this case, because it is less sensitive to the kind of sampling variation that is present here. This is illustrated by the fact that the overall mean is -0.571 but the omission of only a single observation—the -7.100 observation for Maine's 1961 price change—shifts the mean to -0.477 . No single observation affects the median anywhere near so much. In any case, the difference between the two estimates of central value is sufficiently small that we need not argue about which one to pitch upon as the more appropriate. Almost any policy decision would be the same no matter which estimate was used.³

³ An interesting methodological sidelight comes out of an earlier time-series attempt by Lyon. Regressions were computed for each of 37 states for the years 1950-1965, using price and per capita income as independent variables, with per capita sales as the dependent variable. The estimates of price elasticity ranged from $+1.497$ to -1.614 . This gives some idea of the accuracy of any single time-series

Table 1. Arc elasticities for changes in the price of cigarettes in individual states

State	Year of price change	Price in preceding year	Price increase (new price minus old price, divided by old price)	Computed elasticity
		<i>cents</i>	<i>percent</i>	
Illinois	1960	26.4	-1.8	1.725
Iowa	1959	24.8	4.8	1.139
Illinois	1961	25.9	0.3	0.957
Alabama	1955	24.0	2.9	0.863
Connecticut	1956	22.5	8.4	0.802
North Dakota	1963	27.1	5.2	0.517
Delaware	1961	24.6	10.6	0.407
Ohio	1956	20.7	8.2	0.304
Minnesota	1963	28.7	4.9	0.204
New Hampshire	1951	20.2	0.5	0.125
Mississippi	1964	30.4	3.2	0.122
Kentucky	1960	23.9	0.4	0.106
Kansas	1957	22.8	9.6	0.031
Rhode Island	1960	26.0	2.3	-0.032
Nevada	1961	25.9	11.6	-0.100
Tennessee	1963	26.1	11.1	-0.142
Michigan	1962	27.1	6.2	-0.174
Idaho	1955	22.2	7.2	-0.234
Pennsylvania	1955	23.3	5.6	-0.240
Michigan	1960	26.5	4.5	-0.251
South Dakota	1959	24.8	9.7	-0.277
Georgia	1964	29.4	1.0	-0.301
Tennessee	1951	19.4	20.1	-0.302
New Mexico	1955	22.9	7.4	-0.302
Kansas	1964	25.6	9.7	-0.307
Iowa	1963	26.4	5.7	-0.328
Maine	1955	23.0	4.8	-0.329
Pennsylvania	1963	26.8	10.8	-0.346
Arkansas	1951	20.5	18.5	-0.357
New Jersey	1956	23.1	10.3	-0.376
Georgia	1955	23.0	12.2	-0.377
Mississippi	1958	26.1	3.8	-0.383
Mississippi	1962	27.4	11.3	-0.385
South Dakota	1955	22.1	3.7	-0.393
Texas	1955	24.5	0.8	-0.444
New Jersey	1963	28.8	4.2	-0.482
Nebraska	1957	22.4	11.2	-0.511
Mississippi	1955	23.3	5.6	-0.538
Utah	1954	20.8	11.1	-0.541
Michigan	1957	22.9	13.1	-0.549
Minnesota	1959	24.8	7.7	-0.554
Utah	1963	24.9	18.1	-0.600
Kentucky	1954	20.0	16.5	-0.613
Connecticut	1961	26.6	0.8	-0.644
Rhode Island	1964	27.3	9.2	-0.692
Illinois	1959	24.5	7.8	-0.713
Iowa	1953	22.0	0.5	-0.724
Florida	1963	26.3	12.9	-0.734
New York	1959	24.0	6.7	-0.749
Alabama	1959	25.8	10.1	-0.752
New Jersey	1961	26.3	8.7	-0.753
Oklahoma	1961	26.1	9.6	-0.766
Massachusetts	1958	26.7	4.1	-0.805

Table 1. (*Continued*)

State	Year of price change	Price in preceding year	Price increase (new price minus old price, divided by old price)	Computed elasticity
Montana	1957	23.7	27.0	-0.886
South Carolina	1951	21.9	0.5	-0.926
South Carolina	1959	24.4	8.2	-0.971
Connecticut	1963	26.8	3.7	-0.972
Ohio	1959	23.8	8.9	-0.975
Texas	1959	25.6	12.1	-1.018
Minnesota	1961	26.6	7.9	-1.024
Michigan	1961	27.7	-2.1	-1.066
Pennsylvania	1959	26.2	2.3	-1.118
Idaho	1961	26.3	4.1	-1.145
Rhode Island	1958	23.6	9.3	-1.146
North Dakota	1951	22.8	0.4	-1.157
Delaware	1953	21.0	0.5	-1.282
New Mexico	1961	26.9	11.5	-1.339
Nebraska	1963	25.8	6.6	-1.420
South Dakota	1963	26.6	7.1	-1.443
Idaho	1959	25.9	1.5	-1.478
Idaho	1963	28.0	5.0	-2.041
Georgia	1951	24.8	-16.9	-2.092
Maine	1961	26.4	1.1	-7.100

One of the characteristics of this method is that it lends itself to meaningful measurement of the accuracy of the estimate. A 95-percent confidence interval around the median spans -0.346 and -0.713, the twenty-eighth and forty-sixth observations [3, p. 551], suggesting a high reliability for the estimate. The chosen central-value estimate seems quite reasonable in light of previous estimates; it is of the same general order as the time-series estimates and much lower than the cross-section estimate. This estimate can be said to be the elasticity of demand for the 12-month period centered on 6 to 18 months after the price change.⁴

Table 1 shows that in many cases there are considerable differences between the computed arc elasticities for different years for the same state; for example, the observed elasticities for Illinois were +1.725 in 1960, +0.957 in 1961, and -0.713 in 1959. Similarly for Iowa they were +1.139 in 1959, -0.328 in 1963, and -0.724 in 1953; but there are only small differences between successive observations in other states. This leads us to ask how much of a given observation's deviation from the mean

estimate for cigarettes. There is no reason to believe that an aggregate U.S. time series should be more accurate than the estimate for any single state, except that aggregate U.S. population figures are more accurate in intercensal years than are estimates for states.

⁴If monthly data had been available by states, the analysis could have been sharpened by starting the 12-month observation periods at more sensible intervals around the price changes.

is accounted for by the particular elasticity that inheres in the state and how much by chance variation. Therefore, we examined the pairs of estimates for states that appear twice or more in our list. (For states that appeared more than twice, two of the estimates were selected randomly to make a pair.) If the estimates reflect properties of the state, the members of pairs of observations should be relatively close together. We therefore counted the numbers of pairs both of whose members are on the same side of the group median. Only seven are found to be on the same side, as compared to 17 pairs that straddle the median, a result which is "more random" than the random expectation of half being straddles. We may therefore conclude that deviation of a state observation from the median is not a property of the state. This supports our procedure of lumping together all the individual observations and considering them as a sample from which to estimate the elasticity of the United States as a whole.

A useful property of this method is that one may easily examine whether price elasticities differ from place to place, among subgroups within the population, or over the course of time. We shall begin with the last.

Many changes occurred in the cigarette market over the period of this study: for example, the shift to filters, and the growing awareness of the threat to health from cigarette smoking. Therefore, it is interesting to see if there were any systematic changes in elasticity during the period, which this method allows us to examine. The estimates were grouped by years in Table 2.

Table 2. Elasticity estimates grouped by years in which change in the prices of cigarettes occurred

Year	Median elasticity	Number of observations
1951	-0.691	6
1953	-1.003	2
1954	-0.577	2
1955	-0.329	9
1956	+0.304	3
1957	-0.530	4
1958	-0.805	3
1959	-0.971	11
1960	+0.037	4
1961	-0.766	1
1962	-0.279	2
1963	-0.541	12
1964	-0.304	4

No apparent time trend in elasticity observations is found. Besides the light this throws on actual elasticities, it also suggests an absence of secu-

lar trends that might bias our central-value summary estimate. The ability to inspect for such trends seems to be an inherent advantage of the quasi-experimental method; by comparison the time-series method throws together observations from different dates, and the cross-section method yields an estimate that applies to only a single date.

Another interesting question is whether elasticity depends importantly upon income. Theory suggests that the higher per capita income is, the less elastic should demand be. We therefore examined the two median elasticity estimates for the trial states above and below the median per capita disposable income. The median for the lower-income states was -0.419 and for the higher-income states was -0.549 . This does not accord with the theoretical expectation. Furthermore, a significance test⁵ suggests that such a spread or an even wider one would occur frequently by chance. We may therefore conclude that there is no important relationship between income and elasticity over the range of state incomes.

Another question is whether the size of the price change influences the sharpness of response to it. The medians of the observations from price changes less than and greater than 6.7 percent (the median price change) were, respectively, -0.419 and -0.549 . This enables us to conclude that elasticity is not strongly a function of size or price change (see the Nair test earlier), although the difference suggests that a bigger change tends to be associated with a higher elasticity.

A last inquiry was into regional differences in elasticity. The observed medians were -0.743 for the West, -0.360 for the North Central, -0.563 for the North East, and -0.415 for the South. A spread this great or greater would happen quite frequently just by chance even if there were no systematic difference among regions.

At the outset it was noted that price changes might be considered as a device to reduce smoking. And an elasticity of -0.50 or slightly more suggests that price is a not insignificant control variable. It is simply not true that "people will go on smoking no matter what it costs them." If the elasticity estimates can be extrapolated far beyond the range of observation, doubling price would halve sales in the first year, a very large effect by any standard. However, if there are any alternatives which would reduce consumption, and there are [7], tax increases probably should not be used for such purposes, because there may well be a vicious boomerang effect. The higher the price, the further toward the butt-end cigarettes are smoked, and the toxicity per puff increases rapidly as the cigarette grows shorter

⁵ This was a randomization test using Monte Carlo drawings. We asked how often the median of a randomly drawn sample of 56 of the 78 observed values would be outside the observed bracket, -0.419 to -0.549 . Of 20 trials run, only 5 were outside it.

and collects tars. The extent of this effect should be studied carefully before prices are increased to reduce consumption.

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Demand for Farm Tractors in the United States and the United Kingdom

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Econometric studies of the demand for farm tractors in the United States and the United Kingdom are compared within a theoretical framework. The motivation behind the demand for tractor services appears to have been similar, the results being consistent with profit-seeking behavior of farmers whose investment decisions are constrained by uncertainty and available finance. However, whereas the dominant explanatory variable in the United Kingdom has been the real price of tractors relative to agricultural wages, the dominant variable in the United States appears to have been the price of tractors relative to crop prices. In addition, in the United States farm size changes have affected the use of tractor stock and thus the demand for tractors, whereas in the United Kingdom this was not the case. An attempt is made to explain the differences in investment behavior by reference to differences in the structure of the labor force, farm size, and government agricultural price and taxation policies.

IN THE United States and the United Kingdom, the agricultural sector has shown rapid technological change in production when facing low price and income elasticities of demand. Farmers' per capita incomes have thus tended to be volatile and to decline relative to the rest of the economy¹; governmental policy in the United States and the United Kingdom has been directed toward stabilization and reversing this trend. Further, in both countries, farmers tend to be "price takers," being numerous and not exerting much cohesive action in their product and input markets—which are often oligopsonistic and oligopolistic. The tractor market is an example of the latter. In the United Kingdom, over 90 percent of new tractors are supplied by five major manufacturers, who have built up considerable brand loyalty. The tractor market in the United States is similar [4, p. 13].

Thus, backgrounds to the respective tractor markets are and have been similar [4, 14], and also innovations in tractor development and design have been taken up in both countries at roughly the same rate. However, quantitative studies of investment in farm tractors yield different explanations in the two countries. By the nature of econometrics only the more strategic causal factors are represented in any functional relationship [9, Chap. 1]. Our comparison, then, is not that certain factors have influenced farm investment behavior in the United Kingdom and not in the

¹ Particularly if income is measured as managerial income obtained by deducting returns to personal labor and capital investment.

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United States but that the relative importance of various factors differs greatly in the two countries.

Comparison of the Studies

Four studies of tractor investment in the United States have been published, Cromarty [1], Fox [4], Griliches [7] and Hedy and Tween [8], and one study of investment in farm tractors in the United Kingdom, Rayner [16], Rayner and Cowling [17]. All of these studies used single equation regression analyses of annual time-series data.² Before we consider the studies in detail, it seems worthwhile to present a general framework within which they may be evaluated.

The studies by Griliches and Rayner and Cowling are explicitly based on a hypothesis of profit-maximizing behavior over the course of time,³ with allowance for the constraining influences of uncertainty and financial factors, and the functions presented by Cromarty, Fox, and Hedy and Tween imply a recognition of such optimization. The most formal treatment of this optimizing basis for the accumulation of capital is presented by Jorgenson [10, 11]. To maximize net worth, the firm should charge itself the implicit rental on capital services at each point in time and maximize profit in the usual way. This may be likened to the situation in which firms do not own capital but hire capital services and maximize net revenue at each point in time. Applying these results to farm investment behavior gives the optimal or desired level of tractor services at a point in time as a function of price of tractor services, price of product, and prices of other inputs. Given that services are proportional to stock, then the desired level of tractor stock will be determined by the same variables. If the quality of tractors in use changes over the course of time, then it is necessary to allow for such change in measures of tractor stock if the assumption of proportionality between services and stock is to hold. Increasing farm size by influencing capacity utilization will also influence the aggregate demand for tractor services.

The neoclassical model as outlined here assumes instantaneous adjustment to equilibrium or desired stock, whereas in the real world there may be a gradual adjustment over the course of time to this desired level. Thus, it seems useful to add to the investment demand equation an adjustment function relating observed level of capital stock to the desired level. The results of the various studies of tractor demand are presented in Table 1. The first point to notice is that in none of the regressions is the variable for the price of tractor services entered correctly; rather, the

² Cromarty also tried a simultaneous equation model of the tractor market. The results were not as satisfactory as the single equation model, however.

³ We also maintained that our investment function would be unaltered if based on the alternative hypothesis of utility maximization subject to a profit constraint [17].

Table 1. Regression results from studies of investment in farm tractors, United States and United Kingdom, selected periods

Study	Data period	Country	Regression equations ^a	R ²
Cromarty [1]	1926-1956	United States	$Y_t = 2072.47 - 1.345 P_{T,t}/P_{R,t} + 0.043 \Pi_{t-1} + 1.559 S_{t-1} + 0.003X + 134.264 Prog - 0.918 Y_{t-8}$ (0.729) (0.053) (0.333) (0.011) (60.404) (0.184)	0.84
Fox [4]	1921-1962	United States	$Y_t = -85.8 - 13.934 \log P_{T,t}/P_{R,t} + 23.504 \log Size - 7.717 \log Age$ (2.581) (13.041) (3.397) $+98.308 \log F_t + 0.083 C_t + 0.150 S_{t-1}$ (18.696) (0.030) (0.017)	0.95
Griliches [5]	1920-1957	United States	(1) $Y_t = a_0 - 417.1 \log P_{T,t}/P_{C,t} - 1594 \log i + 0.0609 S_{t-1}$ (68.0) (203) (0.0214) (2) $\log S_t = a_0 - 0.254 \log P_{T,t}/P_{C,t} - 1.188 \log i + 0.827 \log S_{t-1}$ (0.042) (0.154) (0.028)	0.91
Handy and Tweenon [8]	1935-1960	United States	(1) $Y_t = 1070 - 3.17 P_{T,t}/P_{R,t} + 0.0177 \Pi_{t-1} - 32.47 A_{t-1} + 37.867$ (0.70) (12.48) (12.12) (2) $\Delta S_t = 789 - 2.95 P_{T,t}/P_{R,t} + 0.0183 \Pi_{t-1} - 26.42 A_{t-1} + 30.70 T_j + 28.08 T_k - 0.089 S_{t-1}$ (0.90) (0.0090) (14.77) (11.17) (11.48) (0.051)	0.92
Rayner and Cowling [17]	1948-1965	United Kingdom	(1) $Y_t = 344.5 - 55.23 \log P_{T,t}/P_{L,t} + 1.163 \log Inv - 27.50 \log S_{t-1}$ (14.13) (0.502) (10.70) (2) $\log S_t = 5.785 - 0.6584 \log P_{T,t}/P_{L,t} + 0.01134 \log Inv$ (0.1496) (0.00530) $+0.3211 \log S_{t-1} - 0.2385 \log P_{T,t}/P_{C,t}$ (0.1146) (0.0545)	0.94 0.998

^a Standard errors are given in parentheses.

Definition of variables
 Y is gross investment in tractors
 S is stock (end of year)
 S_0 is stock (end of year) weighted by age structure
 π is real income
 P_T/P_R is price of tractors divided by prices received
 P_T/P_C is price of tractors divided by price of crops
 P_T/P_L is price of tractors divided by labor earnings

A is acres per farm
 F is number of farms
 C is index of crop production
 $Size$ is average horsepower of new tractors
 i is interest rate
 Inv is investment allowance (tax deductions)
 Age is average age of tractor stock
 $Prog$ is farm price program
 T_k is time, the last two digits of the current year ($J=35-41$; $k=48-60$)

price of tractors—that is the stock price—has been used. Rayner [16, p. 7] explicitly recognized this problem; however, he made the assumption that rental would be proportional to the stock price and that therefore the latter could be used in the regressions. How far this assumption is reasonable would depend in particular on the variation in interest rates over the period considered. Hence, we should bear in mind that this simplification of using the stock price rather than the flow price of tractor services is a possible shortcoming of all the studies.

Of the functions presented, those used by Griliches and by Rayner and Cowling are explicitly based on optimization within a capital stock adjustment mechanism and their results do not refute this hypothesis. In particular, of the price variables for equations (1) and (2) given in Table 1 (the demand function for desired tractor services and desired stock level, respectively), Griliches found that the price ratio of tractors to crops was significant, whereas that of tractors to labor (not presented) was not. In contrast, Rayner and Cowling found the price ratio of tractors to labor and to a lesser extent that of tractors to crops to be important explanatory variables.⁴ The stock demand function presented in both studies makes the *a priori* assumption that the adjustment model is of the form

$$(S_t/S_{t-1}) = (S_t^*/S_{t-1})^g,$$

where S^* is desired stock and g is the adjustment coefficient, which was estimated to be 0.17 by Griliches and 0.68 by Rayner and Cowling.⁵ The gross investment function presented by Griliches assumed, *a priori*, that replacement investment (R_t) was proportional to capital stock⁶ and that the adjustment model was

$$S_t - S_{t-1} = g(S_t^* - S_{t-1}),$$

which leads to

$$Y_t = S_t - S_{t-1} + R_t = gS_t^* + (d - g)S_{t-1},$$

where d is the rate of depreciation. Rayner and Cowling made no *a priori* hypothesis about the adjustment model and the relationship of replacement investment to stock but estimated the best statistical gross investment function with an optimizing basis and recognition of an adjustment problem. This procedure resulted in a semilog function; the negative coefficient on lagged stock indicates, however, a fairly high rate of

⁴ Price ratios have advantages in statistical estimation—see for example the comments of Heady and Tweeten [8, p. 49].

⁵ However, we should not accept the value of adjustment coefficients too literally, since it follows from Malinvaud [12, Chap. 14] and Nerlove and Wallis [15] that when they are estimated from stock adjustment models they are biased by an unknown quantity and in an unknown direction.

⁶ That is, he assumed a declining balance depreciation formula.

adjustment.⁷ Rayner and Cowling also explicitly proposed that financial constraints, as well as uncertainty, would inhibit the adjustment of tractor stock to the desired level. They found that the investment allowances⁸ given in the United Kingdom in the period considered was significant whereas the level of past income (not presented in Table 1) was not. The significant interest rate variable presented by Griliches can be interpreted as a financial variable affecting the adjustment process, although under Griliches' theoretical hypothesis it should be connected with price of capital services. Of the other U.S. studies presented, Heady and Tweeten's net investment function is based on an adjustment model of the linear type presented by Griliches. The nonsignificant coefficient on lagged stocks indicates, however, that this model was possibly inappropriate. Fox's equation may be interpreted as an adjustment model of this type—with a low adjustment coefficient.⁹ Both studies may be interpreted as having an optimizing basis, with the ratio of tractor prices to prices received being significant. Finally, in Heady's study a weighted average of past incomes is significant, indicating a significant influence of capital availability on investment.

An important problem arising from the theoretical model is the degree to which the various studies are able to approximate the demand for tractor services by their stock and investment relations. The Rayner-Cowling study makes a systematic attempt at quality adjustment of the stock and investment series by deflating the value series by an estimated constant quality price index. Hypotheses about the recognition of differing quality by purchasers were tested by comparing models using as alternative dependent variables horsepower, numbers weighted by horsepower, and numbers adjusted for quality differences. As increasing quality recognition was allowed for, the explanatory power of the regressions was consistently increased,¹⁰ leading to the acceptance of the full quality measure as the hypothesis most relevant to the demand for tractor services (the results presented in Table 1 correspond to this measure). With regard to the U.S. studies, Fox, by measuring investment and stock in terms of horsepower, implicitly overcame much of the problem of quality change

⁷ This assumption is compatible with the idea that the negative influence of diminishing marginal productivity of a rising lagged stock level on net investment is more than the positive influence on replacement investment.

⁸ These were capital allowances on new tractors for income tax relief. They were introduced at 20 percent in 1954 for three years, then reintroduced in 1959 and every year until 1965 at varying levels. The existence of tax allowances could be interpreted as a reduced rental on capital.

⁹ Fox, however, does not present this as an adjustment model. Instead, he regresses gross investment on predicted gross investment in $t(y_t)$ and predicts gross investment in $t-1(y_{t-1})$. Not surprisingly, the coefficient of y_t is high and that of y_{t-1} is low; this fact he interprets as rapid adjustment [4, pp. 15-25].

¹⁰ The tractor price variable used in the regression was the one relevant to the degree of quality recognition in the dependent variable.

[4] in his data period (1921–1962) but failed to use the appropriate price variable, that is, price per horsepower. Griliches [5, p. 190] recognized the problem and his gross investment measure does take account of some quality change. Similarly, Heady and Tweeten's measure of gross investment, a price-weighted aggregate of tractor purchases, accounts for an unspecified degree of quality change, whereas Cromarty measured gross investment simply by number. A second point arising from the connection between the demand for services and investment concerns the efficiency of use of services. This is brought out most clearly by Heady and Tweeten's study, where the negative coefficient of the variable, acres per farm, indicates that as farm size increases the efficiency of use of available tractor services increases. Since number of farms is inversely associated with farm size, a similar conclusion emerges from Fox's study. A farm-size variable was used in the U.K. study but was nonsignificant.

Last, the questions of time trend, advertising, and replacement investment arise outside the analytic framework as presented. The time variable in Heady and Tweeten's functions may be interpreted as representing the diffusion of knowledge about and acceptance of tractors or alternatively as a proxy for desire for leisure. However, Griliches found that a time variable was nonsignificant in his study. If Griliches has a "better" measure of investment than Heady and Tweeten, then the time variable may stand as a proxy for quality change, which would increase the productivity of tractors over the course of time and therefore shift the demand curve to the right. On advertising, the U.K. study indicated that advertising *may* have induced farmers to invest somewhat earlier and in a higher-quality model than they might otherwise have done. The problem of replacement investment has generally been circumvented by assuming that it is related in some direct way to lagged stock. Cromarty, however, explicitly considered the way in which replacement investment is related to the age of the tractor stock and found that as the age of stock increases so does investment. Thus, although gross investment is likely to have a simultaneous relationship with age of tractors on farms, if it is undirectional within annual time periods, then increasing age leads to increasing replacement demand. The possible simultaneity of the relationship may explain the negative coefficient on age of stock in Fox's equation, since it included the period when there was a rapid buildup of stock.

The crop production variable used in Fox's study could be interpreted as arising from the neoclassical model where profits are maximized subject to the production function. In this case the output variable is included in the demand-for-input equation instead of its price (product and input) and technology determinants. However, there appears to be some double counting in the Fox equations, for product price appears as a ratio to tractor price in another variable.

The U.S. studies have used long time series and may thus have esti-

mated hybrid structural equations. We have made a limited analysis of U.S. gross investment in tractors, using postwar data only. The results are presented in Tables 2 and 3, Table 2 giving results where the number of tractors is the dependent variable and Table 3 where tractor horsepower replaces tractor numbers. In Table 2, the first equation corresponds to Heady and Tweeten's model, with equation (2) being the semilog version of the same. Equation (3) corresponds to Griliches' model. Equation (3) performs rather badly, with no significant coefficients; and the only significant variables in equations (1) and (2) are the cropland acreage per farm and the trend variables. Comparing equations (4) and (5), we can see that severe specification error results from omitting lagged stock (N_{t-1}), and this error may go some way in explaining the unsatisfactory results for equations (1) and (2). Equations (4), (5), and (6) do not include time as a separate variable because tractors have been a known technology over the postwar period and therefore we would expect demand factors to explain the investment rate. Equation (4) appears most satisfactory. The nonsignificance of lagged income and number of farms may be explained by their high intercorrelation with the cropland-acres-per-farm variable.¹¹ In equation (6) the current index of crop production is substituted for lagged income. Indications are that crop production may influence tractor sales, but again there is a collinearity problem.

In Table 3, equations (1) and (3) correspond to two successful U.K. models. The ratio of tractor horsepower price to crop price is significant and has the expected sign, whereas the ratio relevant to hired labor costs is nonsignificant in (1) and has the wrong sign in (1) and (3). Equation (2) corresponds to Fox's model; the variables—price, size of tractors, and age of tractor stock—now become nonsignificant. Equation (4), a revised version of the Fox model without price variables, is the most satisfactory regression. Introducing cropland acres per farm in equation (5) does not add anything, but there is some indication in equation (6) that the price ratio variable is significant when it replaces the crop production variable. However, the overall effect is a poorer fit.

Thus, it appears that postwar gross investment in tractors in the United States can be explained better in terms of numbers than in terms of total horsepower, in contrast to the U.K. study. Gross investment by numbers is largely explained by lagged income, cropland acres per farm, lagged tractor stock, the age of the tractor stock, and the number of farms. Total horsepower sales are partly explained by crop production (or the real price of tractors), the number of farms, lagged tractor stock, and the age of that stock. In contrast to conditions in the United Kingdom, hired labor costs seem unimportant and the coefficient on lagged stock is significantly

¹¹ Lagged income and number of farms appeared significant and with expected sign in a formulation excluding cropland acres per farm.

Table 2. Regression results for investment in number of farm tractors, United States, 1947-1962^a

Equation	Dependent variable	Constant	P_{T_t}/P_{R_t}	π_{t-1}	A_{t-1}	Time	N_{t-1}	F_t	Age_t	P_{T_t}/P_{G_t}	i_t	C_t	\bar{R}^2	Von Neumann ratio
(1)	Y_{1t}	147.3 (27.4)	0.235 (0.199)	-0.487 (0.432)	-3.310 (0.582)	2.045 (1.038)							0.93	2.44
(2)	Y_{1t}	551.2 (86.2)	1.99 (1.31)	-15.51 (12.40)	-232.6 (37.7)	108.3 (51.1)							0.94	2.62
(3)	$\log_e Y_{1t}$	7.74 (3.97)					\log_e							
(4)	Y_{1t}	-398.4 (694.0)		39.62 (30.46)	-159.13 (54.20)		-0.95 (0.88)	156.38 (101.33)	124.69 (60.36)	-0.15 (1.05)	-0.36 (0.54)		0.57	1.41
(5)	Y_{1t}	1194.0 (361.0)		-22.09 (22.40)	-216.70 (60.11)		124.02 (48.91)	-82.14 (46.06)	-17.96 (26.76)				0.93	2.72
(6)	Y_{1t}	-57.3 (489.7)			-164.51 (50.84)		78.48 (29.24)	102.45 (74.46)	82.67 (47.22)			34.73 (24.37)	0.89	2.01
													0.93	2.41

^a No data on imports of tractors was available; regressions refer to home shipments only. Standard errors are given in parentheses.

Definition of variables

Y_{1t} is annual domestic shipments of wheeled tractors (in tens of thousands)
 P_{T_t}/P_{R_t} is current price of tractors divided by prices received by farmers (index 1957-1959 = 100)
 π_{t-1} is weighted lagged average net income of farmers (in hundreds, deflated by prices-paid index)
 A_{t-1} is cropland acres per farm

Time is the last two digits of year t
 N_{t-1} is stock of tractors (number in hundreds of thousands) Dec. 31st.
 F_t is number of farms (in millions)

Age_t is average age of current tractor stock

P_{T_t}/P_{G_t} is current price of tractors divided by price of crops (index 1957-1959 = 100)

i_t is current Federal Reserve discount rate

C_t is current index of crop production (1957-1959 = 100)

Sources: Federal Reserve Bulletin [2], Fox [4], and USDA [21].

Table 3. Regression results for investment in horsepower of farm tractors, United States, 1947-1962^a

Equation	Dependent variable	Constant	i_t	P_{Ht}/P_{Lt-1}	H_{t-1}	C_t	P_{Tt}/P_{Rt}	P_{Ht}/P_{Ct-1}	Size _t	F_t	Age _t	A_{t-1}	\bar{R}^2	Von Neumann ratio
(1)	Y_{1t}	9.90 (1.85)	-0.61 (0.39)	0.01 (0.01)	0.26 (0.12)	0.13 (0.06)	-1.92 (4.75)		8.25 (10.25)	75.99 (32.78)	11.89 (8.54)		0.13	1.99
(2)	Y_{2t}	-200.0 (98.3)											0.53	3.50
(3)	Y_{3t}	-3.44 (11.21)											0.39	2.54
(4)	Y_{4t}	-261.0 (75.4)				11.54 (5.20)				52.25 (14.90)	17.11 (8.30)		0.61	0.11
(5)	Y_{5t}	-284.3 (123.9)				12.12 (5.94)				55.37 (20.06)	18.00 (9.29)	3.05 (12.50)	0.61	3.26
(6)	Y_{6t}	-111.6 (109.9)				26.35 (7.68)				41.98 (19.05)	24.69 (10.16)	-25.56 (14.94)	0.50	3.28

^a The price-per-h.p. series was estimated from two series on shipments of tractors. Standard errors are given in parentheses.

Definition of variables

Y_{it} is current horsepower purchases (in millions)

P_{Ht}/P_{Lt-1} is current price per tractor horsepower, divided by agricultural labor earnings_{t-1} (index 1957-1959 = 100)

H_{t-1} is stock of tractor horsepower December 31, t-1

Size_t is average size of tractors purchased (horsepower)

P_{Ht}/P_{Ct-1} is current price per tractor horsepower, divided by crop prices_{t-1} (index 1957-1959 = 100)

P_{Tt}/P_{Rt} , C_t , F_t , Age_t, A_{t-1} are defined as in Table 2.

Sources: Same as for Table 2.

positive in both models, whereas in the U.K. full-quality model it was significantly negative.

Comparing the previous U.S. studies with the new results for the postwar period, we can make two important generalizations: (1) the models explain numbers much better than they explain total horsepower; and (2) although the explanatory power for tractor numbers is high, the parameter estimates are not well determined. The first situation suggests that the models explaining horsepower are subject to specification error, which may be overcome by using a trend variable as a proxy for the upward shift in leisure desire. The second observation is consistent with a high degree of multicollinearity resulting from the short series of highly autocorrelated explanatory variables. This situation might have been avoided by the inclusion of data from the prewar period, when the series displayed substantial cyclical variability.

Comparison of Demand Characteristics

The demand for tractors is a derived demand for a flow of services from the tractor stock on hand. U.S. and U.K. stocks show similar growth patterns, both when measured in numbers and when measured in total horsepower. Griliches [6] describes the uptake of a technological innovation as a logistic growth curve; his description and terminology seem appropriate here. Figures 1 and 2 (of the postwar period) indicate that stock, measured in numbers, has reached a ceiling (or equilibrium level) on its growth curve, in both countries. This is not so with total horsepower, although the rate of growth of stock is slowing down. A consequence is that in both countries available tractor horsepower per farm rose from around 12 h.p. per farm in 1947 to around 42 h.p. per farm in 1962 [4, 16, 19, 21].

Although stocks show similar overall patterns, postwar gross investment patterns are not so similar (Figs. 3 and 4). This would seem to reflect the fact that the relative growth of stocks (number and horsepower) has been quicker in the United Kingdom than in the United States. That is, over the postwar period there has been a higher "rate of acceptance" in the United Kingdom.¹² In turn, this is related to the influences on demand in the two countries. Although the same variables do not enter the investment functions for each country, it seems reasonable to accept, from the results, that there was a similar behavioral basis for investment in each country—profit-maximizing behavior leading to adjustment of tractor

¹² The actual rate of acceptance as defined by Griliches [6] has not been measured but, given the upward trend in stock, coefficients of variation of stock indicate relative growth rates. These are, with respect to numbers, 0.17 for the United States and 0.22 for the United Kingdom, and, with respect to horsepower, 0.24 for the United States and 0.34 for the United Kingdom.

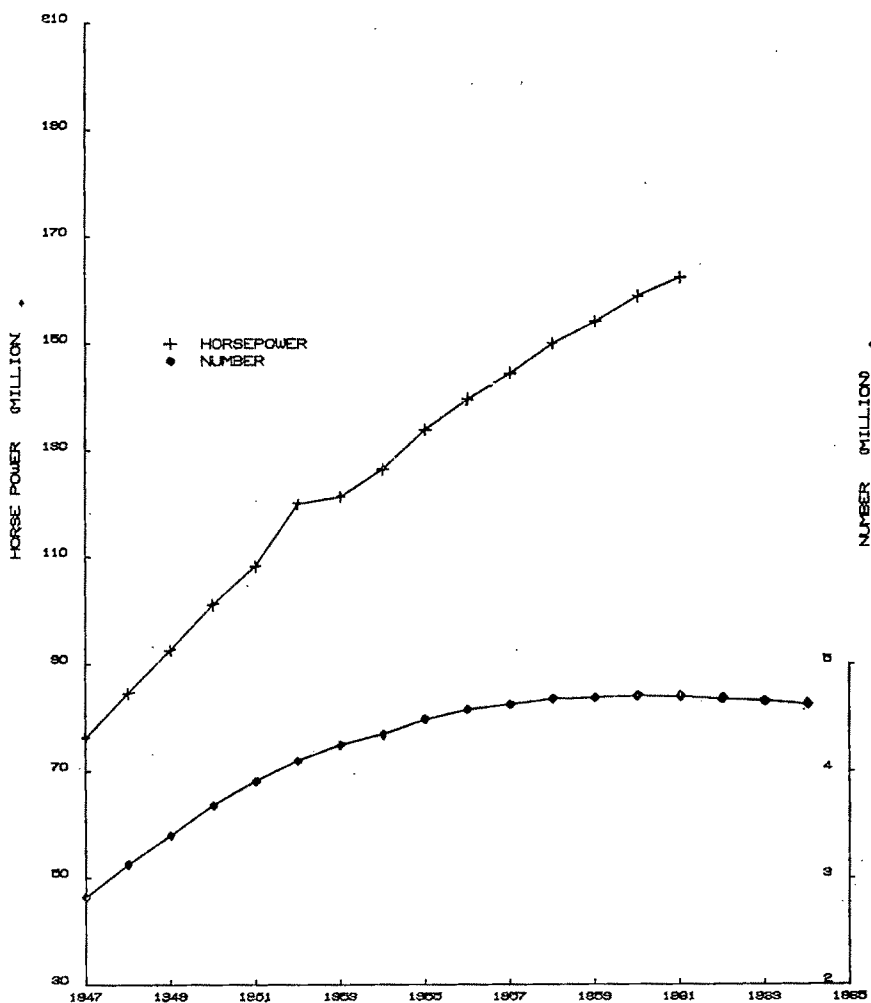


Figure 1. Stock of tractors in the United States (end of year)

stocks toward a desired level, which would provide a desired level of services. However, the variables associated with this profit-maximizing adjustment do not have the same importance in the two countries. In the United Kingdom the price ratio of tractors to labor was of major importance, with the price ratio of tractors to crops of secondary importance. In contrast, in the United States the price of tractors relative to that of crops was the important price ratio, with the price of labor nonsignificant. The adjustment rate appeared to be higher in the United Kingdom¹³ than in the United States, probably a result of the differing time periods studied.

¹³ Note the proviso concerning bias mentioned earlier.

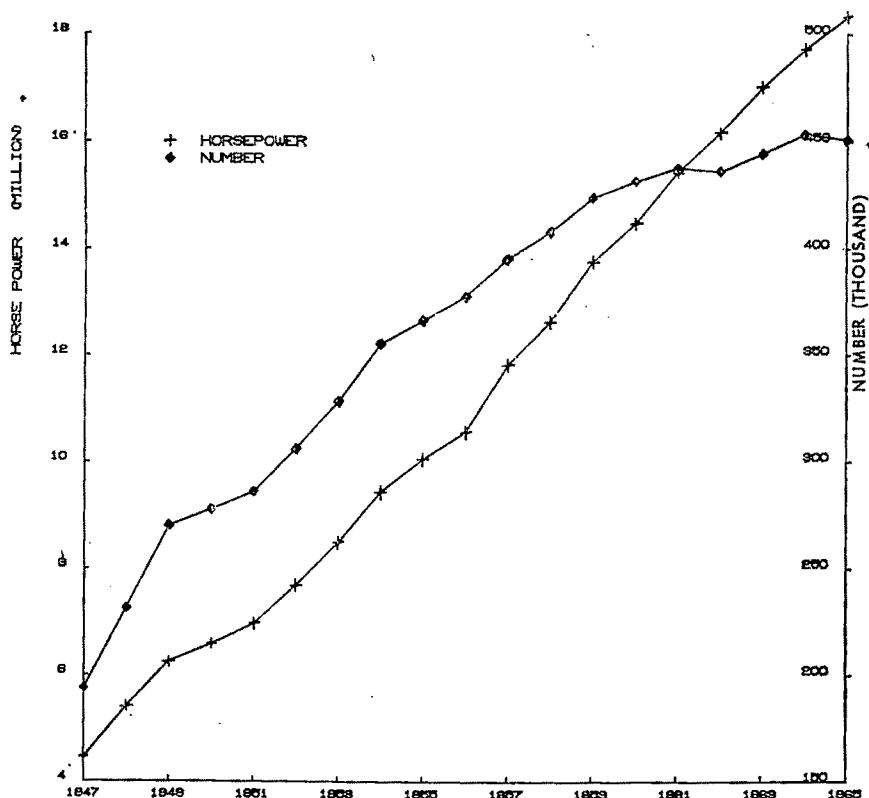


Figure 2. Stock of tractors in the United Kingdom (end of year)

We would expect the adjustment rate to be lower in earlier years, particularly before the war, when tractors were not such a "known" technology.¹⁴ The lack of full adjustment appears to have been a result of financial constraint as well as uncertainty; in the United Kingdom investment allowances were important; in the United States the interest rate and lagged real net farm income were significant variables in the prewar period. Evidence from the U.K. study indicates that if we are to specify our investment function properly—as a derived function in relation to the demand for services—then we should take account of changing tractor quality. To some extent the U.S. studies also recognized quality changes. However, from the regressions presented on postwar investment, it appeared that investment by numbers was explained better than investment measured as total horsepower. This is surprising, given the change in the average horsepower of purchased tractors from 26 h.p. in 1947 to 54 h.p. in 1962

¹⁴ The equations in Table 2 indicate a low adjustment coefficient; we will return to this later.

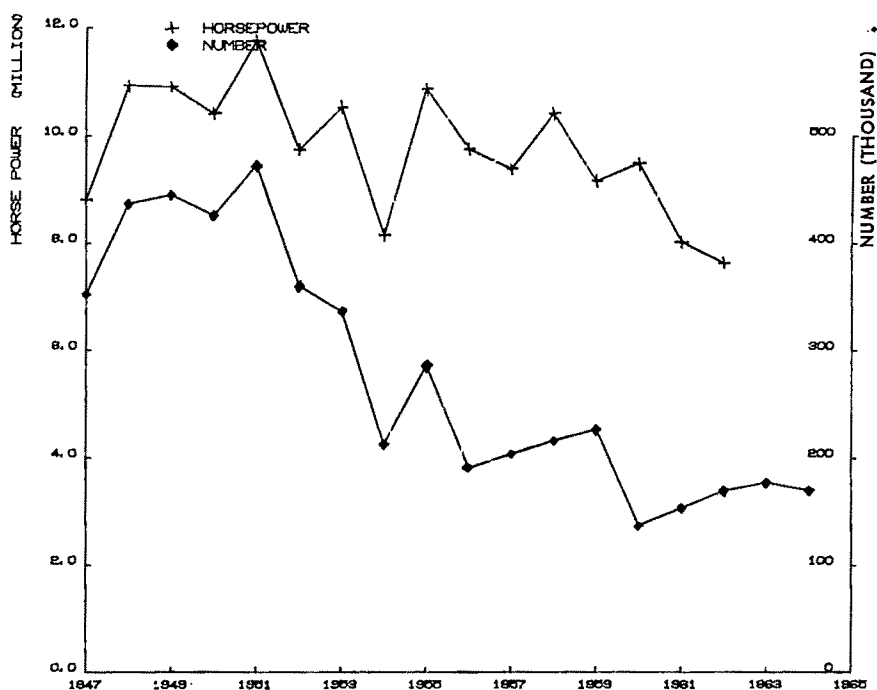


Figure 3. Gross investment in farm tractors in the United States

[4], a change similar to that which occurred in the United Kingdom (from 24 h.p. in 1947 to 50 h.p. in 1965). Given that this quality change was the result of farmer demand, since in any one year many models differing in horsepower would be available, then it seems likely that the lower explanatory power of the horsepower functions was the result of omitted variables. In particular, the desire for leisure¹⁵ of family labor, given the importance of farm family labor in U.S. agriculture, may have been important in influencing the demand for higher-quality tractors. If this was so and, as seems likely, this leisure demand was rising over the course of time, then omission of the variable would lead to specification bias resulting in an upward (that is, positive) bias on the coefficient of lagged stock.¹⁶ This would then go some way toward explaining the large positive coefficient on lagged horsepower stocks, the latter being a some-

¹⁵ The desire for leisure is used here as a conglomerate term including the desire to reduce the working week of family labor in order to increase not only leisure but also part-time nonfarm employment (the relevant variable would then be the ratio of tractor price to nonfarm wages).

¹⁶ Since desire for leisure would have a positive coefficient in the investment function and would be positively associated with lagged tractor stock. See Theil [18] for a full explanation of the conditions for specification error.

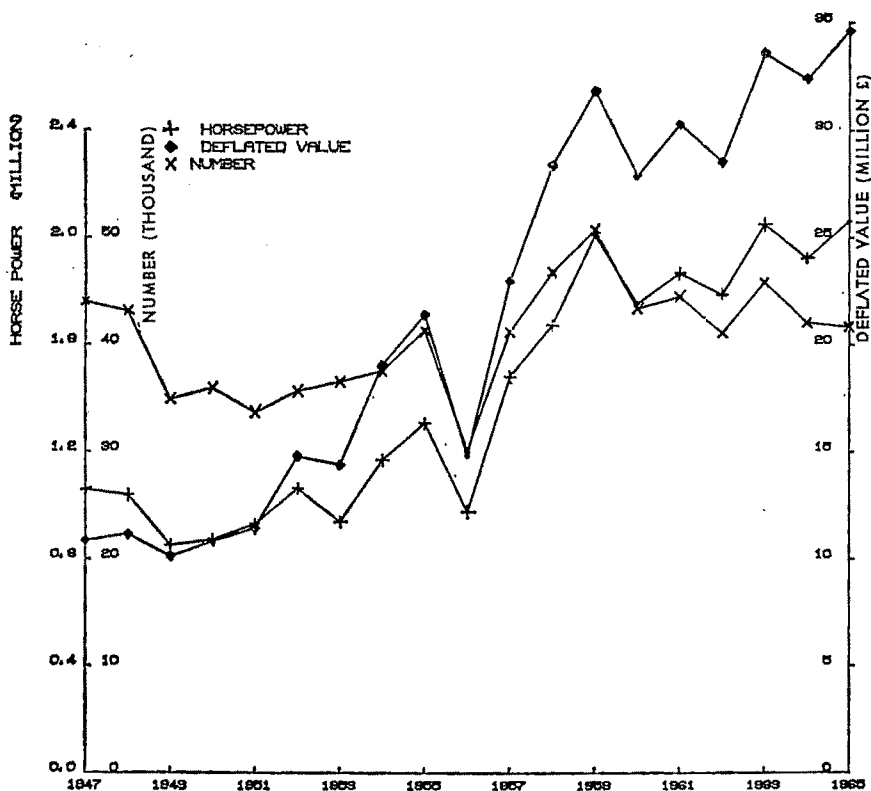


Figure 4. Gross investment in farm tractors in the United Kingdom

what surprising result in view of the fact that a variable influencing replacement demand (age of stock) was included in the regressions.

Finally, variables which improve the use of existing tractor stock were shown to influence investment in the United States, but not in the United Kingdom. In the United States the continuing rise in cropland acres per farm and the associated decline in number of farms had a depressing influence on investment.

Structural Backgrounds and Interpretation

In both the United States and the United Kingdom, farmers are numerous, operating as entrepreneurs (owner-managers) and with access to finance only from their own private sources (for example, profits) and from financial institutions. In addition, they face uncertainty through the lack of market control and the influence of exogeneous factors, primarily weather, on their production processes. Hence, it is not surprising that the studies indicate similar motivation behind tractor investment—profit seek-

ing influenced by considerations of uncertainty and availability of finance. However, the different factors surrounding this motivation appear to have had different strengths in the two countries.

One of the more striking contrasts is in the influence of the cost of hired labor. Tractor investment in the United Kingdom has been strongly influenced by the price of tractors relative to the cost of labor, whereas this factor seems to have been unimportant in the United States. This can be related to the greater importance of hired labor in U.K. agriculture, where, over the postwar period, hired labor has accounted for at least 50 percent of total labor input [19] compared to around 25 percent in the United States [20]. Further, labor costs form a much higher proportion of total production costs in the United Kingdom than in the United States: in the United Kingdom the proportion fell from around 30 percent in 1950 to around 20 percent in 1960 [20], compared to a fall from around 24 percent to 10 percent in the United States [21]. Finally, there is more scope for labor substitution in the United Kingdom, where the man-land ratio is relatively higher. The differing structures of the agricultural labor force in the two countries may also mean that the desired level of available tractor services in the United States is much more related, in the aggregate, to farm family leisure demand (including off-farm work) than in the United Kingdom.¹⁷ That is, tractor services in the United Kingdom mainly substitute for hired labor; in the United States, substitution for family labor is also important.

A second institutional feature which can be related to contrasts between the studies is that of governmental policy toward agriculture. In particular, in the United Kingdom the practice of giving investment allowances on new tractors appears to have increased the rate of take-up of technological advance as incorporated in tractor quality. A second feature has been the different governmental agricultural support policies in the two countries. The United Kingdom operates a deficiency payment system¹⁸ (now linked to standard quantities) which covers all major commodities and under which total guarantees cannot be reduced by more than 2½ percent per annum; the United States operates tariff and stock

¹⁷ Adapting from the idea of a managerial utility function as put forward by Marris [13] and Williamson [22], we might hypothesize a farmer utility function with at least profits and leisure entering. The simplest model (lexicographic) would suggest that profits are a constraint (probably with an upward trend through time) and that leisure is maximized subject to that constraint. More generally, we might suggest a continuous trade-off between leisure and profits. Investment in tractors would represent the vehicle by which the farmer obtained his desired leisure position. This would be affected by variations in the real price of tractor power, which would determine the level of profits corresponding to any particular leisure position.

¹⁸ The deficiency payment system was started in 1947 and included a form of long-term guarantee with regard to prices, although the 2½-percent guarantee itself was not introduced until 1957.

policies. It may be (a) that the former system creates an investment climate of less uncertainty leading to higher adjustment coefficients and (b) that product price expectations as measured by present or lagged product prices have less influence on the investment decision in the United Kingdom than in the United States.

Finally, farm size is greater and has risen faster during the postwar period in the United States¹⁹ and farm fragmentation is probably less. This is likely to lead to greater efficiency in the use of tractor stock in the United States than in the United Kingdom and to a depressing influence on investment. This hypothesis is consistent with the observed negative and significant coefficient in the U.S. studies on the variable cropland acres per farm.

Conclusions

Over the past four to five decades, the expanding use of tractors on farms has been a significant technological change in the production structure of U.K. and U.S. agriculture. In both countries it appears that stock, measured by numbers, has now reached a ceiling level, but that, measured by quality, it is still rising. Similarities and differences in the forces affecting this type of technological progress in the two countries can be related, to some extent, to the structures of, and institutional backgrounds to, the U.S. and U.K. agricultural sectors. The institutional backgrounds also imply the influence of certain possibly unquantifiable causes, such as the desire of family labor for increasing leisure.

In the long run, demand in the United Kingdom is likely to become more like that in the United States in some ways as labor costs become less important in the production expense budget and farm size increases.

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¹⁹ Estimated cropland acres per farm rose from around 40 acres per farm in 1947 to 50 acres per farm in 1962 in the United Kingdom [19] compared to a rise in the United States during the same period from 60 acres per farm to 90 acres per farm [2].

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Importance of the Farm Sector to the Economy: A Multiplier Approach*

ABBAS MIRAKHOR AND FRANK ORAZEM

A mathematical model is presented, which uses a multiplier approach to determine the relation of farm income to total income in a community, state, or region. Application of the model to Kansas data for the years 1950 to 1966 showed (a) that, on the average, \$1.00 of farm income generated \$3.33 of total income, whereas \$1.00 of nonfarm income generated only \$1.46 of total income, (b) that the farm sector expended 88.4 percent of its income in the nonfarm sector, whereas the nonfarm sector expended only 10 percent of its income in the farm sector, and (c) that there was an increasing interdependence between the farm and nonfarm sectors from 1950 to 1966.

IN A rapidly growing industrial economy such as that of the United States, the importance of the farm sector and its contribution to the total economy has been receiving less and less emphasis and often has been overlooked. The farm share of the gross national product is declining; the economic importance of farm income, however, is increased by the way in which agriculture is becoming ever more interdependent with other industries. The growing complexity of highly mechanized farming has created greater and stronger linkages between the farm sector and the rest of the economy. On-farm adjustments and developments have brought about commercialization of the farm sector as farm production has become more dependent on purchased off-farm inputs [8, p. 7], which have an important influence on local, state, and regional economies.

Comparative advantages of large-scale farm production increasingly localize the farming industry, so that the rest of the country becomes dependent on a few regions to supply its farm product needs. In such areas, a major portion of the demand for farm products is exogenously determined and export sales are a major component of farm income. Farm sectors in agriculturally oriented economies, like the state of Kansas, use locally, for capital, production, and consumption expenditures, a high percentage of income so earned. This local use creates a multiplier effect within the economy which increases the importance of farm income in determining total income in these economies. The linkage process can be idealized as shown in Figure 1. The purpose of this article is to quantify the role and in-

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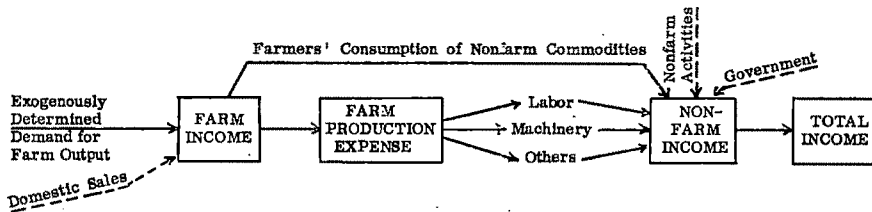


Figure 1. Suggested linkage process in determination of total income of an agriculturally oriented economy

fluence of farm income in determining nonfarm income and consequently the total income of such economies.

The Multiplier Concept

The multiplier concept has been traced to the late nineteenth century [1, 2, 10, 13]. It was popularized by R. F. Kahn in the 1930's in connection with the development of an employment multiplier [3, 4]. J. M. Keynes extended the concept by developing the investment multiplier [5]. Since then, the multiplier concept has been extended to many economic analyses; and various types of multipliers, such as foreign-trade, money, geographic, and population-growth multipliers, have been developed [2, pp. 153-200]. The reason that the concept lends itself well to economic research is indicated by O. Lange, who defined the multiplier as "the marginal effect of a change of one economic variable upon another economic variable, of which the first is a component" [6, p. 227]. The definition suggests that if it is possible to divide an economic variable into its different components, it is permissible to determine the changes that take place in the original variable as a result of a change in one of its components. Moreover, by the same token, we can determine marginal relationships among various components if we can establish interdependency among the components [2, p. 154].

It therefore appeared that dividing the total income of a community, state, region, or country into two components of farm income and non-farm income would permit us to determine the amount of total income created by a dollar of either farm or nonfarm income. Also, in regions where the farm sector contributes a major share of its income to the nonfarm sector through capital and consumption expenditures, we can determine the importance of farm income to nonfarm income by determining the farm income-nonfarm income multiplier for that region.

The Model

Multipliers in general can be divided into "static" and "dynamic." The first applies to a "static" economic system and "occurs in comparative equilibrium systems in which time has no place" [2, p. 153]. The second is

concerned with the analysis of changes occurring in the economic variables within the system over the course of time. The dynamic multipliers themselves can be divided into two categories: (1) the comparatively static multipliers, which permit comparison of changes occurring in two time periods—for example, t_1 and t_2 , and (2) “process” or “period” multipliers, which permit analysis of changes occurring in a series of time periods—for example, $t_1, t_2, t_3, \dots, t_n, t_{n+1}, \dots, t_\infty$. These multipliers themselves are time-variant. They may refer to either a limited or an unlimited length of time. Dynamic multipliers covering a limited time span are called “truncated”¹ multipliers. In this article, the multipliers are the truncated type.

The model developed below, along with the multiplier concept, uses some concepts of input-output and regression analyses.

Derivation of total income multipliers

To derive the farm income-total income and nonfarm income-total income multipliers, we assume

$$(1) \quad Y_t = YF_t + Y(F.N)_t,$$

which states that the total income of a region (Y) at time period t is equal to the farm income (YF) plus the nonfarm income (YN) during the same time period. Dividing both sides of (1) by Y_t , we have

$$1 = \frac{YF_t}{Y_t} + \frac{YNF_t}{Y_t},$$

designating

$$(2) \quad \frac{YF_t}{Y_t} = \alpha_t$$

and

$$\frac{YNF_t}{Y_t} = \beta_t.$$

We now have

$$(4) \quad \alpha_t + \beta_t = 1,$$

which permits construction of two systems of simultaneous equations:

System A

$$\begin{cases} Y_t = YF_t + YNF_t \\ YF_t = \alpha_t Y_t \end{cases}$$

¹ This term was first used by Samuelson [9, pp. 221-227].

and

System B

$$\begin{cases} Y_t = YF_t + YNF_t \\ YNF_t = \beta_t Y_t \end{cases}$$

System A's solution gives

$$(5) \quad Y_t = \left(\frac{1}{1 - \alpha_t} \right) YNF_t$$

and System B's solution gives

$$(6) \quad Y_t = \left(\frac{1}{1 - \beta_t} \right) YF_t$$

(For the derivation of simple multipliers, see Lange [6], Little [7] and Tiebout [12].) Thus, the farm income-total income multiplier $[1/(1-\beta_t)]$ and nonfarm income-total income multiplier $[1/(1-\alpha_t)]$ are obtained. With given data, we can observe the past behavior of both and, thus, the past contributions and importance of farm and nonfarm income to total income for any given time. And if it is desired to determine the average multipliers over a given time span, they can be found as follows:

$$(7) \quad \lambda = \frac{\sum_{t=1}^n \left(\frac{1}{1 - \beta_t} \right)}{n}$$

and

$$(8) \quad \mu = \frac{\sum_{t=1}^n \left(\frac{1}{1 - \alpha_t} \right)}{n}$$

where λ and μ are the average farm income-total income and nonfarm income-total income multipliers, respectively.

Determination of farm-nonfarm and nonfarm-farm income multipliers

Along with equation (1), we assume the following relationship:

$$(9) \quad YF_t = Y(F.F.)_t + Y(F.NF)_t,$$

which is an expenditure equation dividing the farm income into the portions that will be spent in farm and nonfarm sectors; for example, $Y(F.N)$ is the intersectoral flow between farm and nonfarm income. And similarly,

$$(10) \quad YNF_t = Y(NF.NF)_t + Y(NF.F)_t.$$

From these relationships, we can set up the income flow indicated in Table 1. The multipliers then can be determined as follows:

$$(11) \quad a(F.F)_t = \frac{Y(F.F)_t}{YF_t}$$

$$(12) \quad a(F.NF)_t = \frac{Y(F.NF)_t}{YF_t}$$

Table 1. Interdependency among farm, nonfarm, and total incomes

From \ To	Farm	Nonfarm	Total
YF_t	$Y(F.F)_t$	$Y(F.NF)_t$	YF_t
YNF_t	$Y(NF.F)_t$	$Y(NF.NF)_t$	YNF_t
			Y_t

$$(13) \quad a(NF.NF)_t = \frac{Y(NF.NF)_t}{YNF_t}$$

$$(14) \quad a(NF.F)_t = \frac{Y(NF.F)_t}{YNF_t}$$

which can be summarized as in Table 2. The necessary conditions for these relationships to hold are the following:

$$(15) \quad a(F.F)_t + a(F.NF)_t = 1$$

and

$$(16) \quad a(NF.NF)_t + a(NF.F)_t = 1.$$

Table 2. Coefficients of interdependence between farm and nonfarm sectors

From \ To	Farm	Nonfarm	Total
Farm	$a(F.F)_t$	$a(F.NF)_t$	1
Nonfarm	$a(NF.F)_t$	$a(NF.NF)_t$	1

To find the multipliers over some finite time period, $t = 1, \dots, n$, tables such as the ones given here have to be set up over that time span and then an average taken as follows:

$$(17) \quad \bar{a}_{ij} = \frac{\sum_{t=1}^n (a_{ij,t})}{n}.$$

(Subscripts i and j change according to the computation of the desired multiplier.)

Developing a predictive equation

The last step in developing the model is an equation to predict next year's income, based on past observations of farm income and/or nonfarm income and the relevant multipliers. The form of equation (1) permits two possible approaches in developing the desired equation. The first regresses this year's farm income and its multiplier on last year's farm income and its multiplier,

$$(18) \quad YF_t = A + BYF_{t-1}$$

and

$$(19) \quad \left(\frac{1}{1 - \beta_t} \right) = A' + B' \left(\frac{1}{1 - \beta_{t-1}} \right),$$

and then substitutes the results in equation (6):

$$(20) \quad Y_t = \left[A' + B' \left(\frac{1}{1 - \beta_{t-1}} \right) \right] [A + BYF_{t-1}].$$

Or we can do the same with nonfarm income and its multiplier,

$$(21) \quad YNF_t = a + bYNF_{t-1}$$

and

$$(22) \quad \left(\frac{1}{1 - \alpha_t} \right) = a' + b' \left(\frac{1}{1 - \alpha_{t-1}} \right),$$

and substitute in equation (5):

$$(23) \quad Y_t = \left[a' + b' \left(\frac{1}{1 - \alpha_{t-1}} \right) \right] [x + bYNF_{t-1}].$$

The choice between equations (20) and (23) depends on which set of regressions—(18), (19) or (21), (22)—gives the better fit for obtaining the total income estimate. With either equation, a point and confidence interval estimate can be derived.

Application of the model to the Kansas economy

The model in its entirety was applied to the economy of Kansas over the period 1950–1966. The total (personal) income multipliers—that is, λ (average farm income multiplier) and μ (average nonfarm income multiplier) of equations (7) and (8)—were about 3.33 and 1.46, respectively [8, p. 8]. The multipliers for the individual years varied between a high of 4.6 in 1957 and a low of 2.1 in 1962 for farm income–total income over the period, and between a high of 1.7 in 1950 and a low of 1.3 in 1957 for nonfarm income–total income. On the basis of 17 observations, we determined that \$1.00 of farm income generated on the average \$3.33 of total (personal) income each year. Income-flow tables similar to Table 1 were set up for 1950–1966, and subsequent multipliers were computed. On the average, 90 percent of nonfarm income was absorbed by the nonfarm sector and only 10 percent was contributed to the farm sector. Farm income, on the other hand, contributed 88.4 percent of its income to the nonfarm sector. In estimating the predictive equation, we found that equations (21) and (22) gave the best fit. Their corollaries are

$$(21a) \quad Y(N.F)_t = 91.30 + (1.04)YNF_{t-1} \\ (0.07)$$

and

$$(22a) \quad \left(\frac{1}{1 - \alpha_t} \right) = 0.43 + \frac{(0.69)}{(0.13)} \left(\frac{1}{1 - \alpha_{t-1}} \right).$$

Coefficients of correlation were computed to be 0.97 for equation (21a) and 0.83 for equation (22a). The Theil–Nagar test of independence [11] was used to determine the presence of serial correlation in the residuals from regression equations (21a) and (22a). The Von Neumann ratios were 1.31 for (21a) and 2.02 for (22a) for the 15 observations 1951–1965. This did not provide a basis for rejection of a null hypothesis that the true serial correlation is zero in both equations at the 1-percent level of significance.

From the two preceding equations, the following predictive equation was obtained:

$$(23a) \quad Y_t = 39.59 + 0.50YNF_{t-1} + 62.61 \left(\frac{1}{1 - \alpha_{t-1}} \right) \\ + 0.71 \left(\frac{1}{1 - \alpha_{t-1}} \right) YNF_{t-1}.$$

This equation was used to estimate the total personal income for the period 1950–1966. The estimated total personal income varied from the actual

personal income, on the average, by 5.1 percent; the variation ranged from a low of 0.6 percent in 1966 to a high of 10.6 percent in 1953.

Thus, the application of the model to the Kansas economy showed that, in Kansas, (a) a dollar of farm income generates more than twice as much total income as a dollar of nonfarm income, (b) a large part of farm income is expended in the nonfarm sector but only a small part of nonfarm income is expended in the farm sector, and (c) there has been an increasing interdependence between the farm and the nonfarm sectors.

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Measurement of Leakage by the Use of an Input-Output Model

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Leakage due to the importation of goods and services is an important consideration in an impact analysis, since leakage reduces the multiplier effect. Through use of the input-output technique, leakage coefficients can be estimated in order to determine the dampening effect of imports on sector multipliers. The only additional data requirement is information on the distribution of imports among the sectors of an economy. Leakage coefficients measure the indirect as well as the direct effects of the importation of goods and services. Leakage coefficients for changes in total output, income, and employment can be estimated from the standard input-output model. Leakage coefficients are useful in research on area development, where measures of the total economy are needed. Estimates can be made of the "loss" of economic activity in a region due to imports and the "gain" which results from reducing imports. It is possible to estimate the reduction in leakage resulting from the elimination of part or all of the imports of one or more sectors of an economy.

A PROBLEM often encountered in area development research is economic leakage. Leakage has been defined [5, p. 141] as that portion of a given stream of spending which is not respent within the period considered. Hansen [4, pp. 89-90] referred to the following sources of leakage: "(1) a part of the increment of income is used to pay off debts; (2) a part is saved in the form of idle bank deposits; (3) a part is invested in securities purchased from others, who in turn fail to spend the proceeds; (4) a part is spent on imports, which does not help home employment; and (5) a part of the purchase is supplied by excess stock of consumers goods which may not be replaced."

Leakage is particularly relevant when one is using economic multipliers to measure the impact of an induced change in an economy. A recent study by Wadsworth and Conrad [11] measured the leakage associated with employment and income multipliers in a rural area. They stated that leakage included "(1) income spent outside the study area by both residents and non-residents employees, (2) income used to reduce existing debts without incurring new ones, (3) increased savings, and (4) substitution of local employment for jobs outside the area" [11, p. 1198].

The Effect of Leakage on Regional Multipliers

Generally, as economic activity within a region decreases, the region depends more on imports. As leakage due to imports increases, the multiplier effect is reduced. Recent research supports this idea. Palmer *et al.*

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[9, p. 31] estimated multipliers for 14 different communities. The size of the communities ranged from 6.5 thousand in Auburn, Washington, to 12 million in New York City. The multiplier for the New York metropolitan area was over two and one-half times larger than for the Auburn community. The size of the multiplier tended to vary directly with the amount of economic activity, since there was a close correlation between the size of community and the amount of economic activity. The economies of the large communities more nearly conformed to a closed economy, because of fewer imports and exports. As a result, the multipliers for these communities were larger.

Another analysis by Rao and Allee [10, pp. 48-49] indicated the relationship between the size of a multiplier and the amount of economic activity within a region. Their conclusions were derived from a five-sector input-output analysis for the state of California and a county within the state. Results showed that in all five sectors the multipliers for the state were larger than for the county.

The necessity for considering the leakage effect as economic activity decreases in a region is evident from these studies. Measurements of leakage for each sector of the economy would be useful in determining the impact of various economic changes in a region. The intent here is to illustrate how leakage due to imports can be computed from the sector multipliers obtained from matrix multipliers [5, pp. 180-183]. Matrix multipliers have been developed from the input-output analysis now used by many regional economists [7]. Output [1, pp. 70-73], income [6] and employment [8] multipliers have been developed.

The multiplier effect, measured by a regional input-output model, is defined as the total change in an economy due to some stimulus in a particular sector, such as change in the final demand for the products of a sector. The total effect is the sum of the direct effect of the change and any secondary or indirect effects resulting from circulation of new capital in the economy. Leakage as defined here is the dampening of the multiplier effect resulting from the import of goods and services and the export of funds to pay for these. The amount of leakage depends directly on the imports of each sector.

The Computation of the Leakage Coefficient: Illustrated with the Oklahoma Model

An input-output model using secondary data for 1959 was devised for Oklahoma [2]. The model consisted of nine endogenous and six exogenous sectors. The amounts of imports and outputs are residuals and thus are net imports and exports. The transaction table is shown in Table 1.

Estimation of the amount of leakage through input-output analysis involves two separate flow tables for the economy. The original flow table

includes an import row and an export column. The original flow table is modified by taking the entries in the import row for the endogenous sectors and separating them into the amounts imported from each sector. The figures are then added to the appropriate entries in the endogenous portion of the table (Table 2).¹ In order to modify the flow table, one needs *a priori* information on the distribution of imports among sectors.

As an example of how the original flow table is modified, consider the imports of the livestock and livestock products sector. For the Oklahoma model, the import entry of \$6,336,000 of goods and services into this sector was divided as follows: \$3,570,000 of agricultural processing products, \$2,679,000 of manufacturing products, \$57,000 of services, and \$30,000 of goods and services from the wholesale and retail sector outside the state.² These imported amounts are next added to the corresponding figures in the column for livestock and livestock products, eliminating the import entry. The same procedure is used for each sector to complete the modified table. The original flow table represents the system of flows for the economy with its present import situation, whereas the modified table represents the system of flows for the economy with no imports of goods and services into the region.

The technical and interdependent coefficients are computed for both the original table and the modified table. The interdependent and modified interdependent coefficients are shown in Tables 3 and 4. From these coefficients, the input-output multipliers are computed. The multipliers from the interdependent coefficients indicate the impact of a change with the present import situation, whereas the multipliers derived from the modified interdependent coefficients indicate the impact with no imports.

The leakage effects are obtained by taking the difference between the two sets of multipliers. The multipliers from the interdependent coefficients are subtracted from those from the modified interdependent coefficients. The multiplier computed under the assumption of no imports is always the largest, so the leakage coefficients are positive. If the region is self-sufficient, the flow tables, interdependent coefficients, and multipliers are identical.

Empirical Results of the Oklahoma Analysis

Output multiplier

The output multiplier measures the change in total output resulting from a one-dollar change in final demand for the products of a particular sector. The output multipliers computed from the original and modified interdependent coefficients of the Oklahoma model are shown in Table 5.

¹ See our 1967 paper [3] for an illustration of how a flow table is modified.

² The procedure for allotting all imports among sectors for the Oklahoma model can be found in Doeksen [2, pp. 112-114].

Table 1. Interindustry flows of goods and services, Oklahoma economy, 19

Activity	Livestock and livestock products	Crops	Agricultural processing	Manufacturing	Transportation, communication, and public utilities	Real estate, finance, and insurance	Services
<i>.....thousands of dollars.....</i>							
Livestock and livestock products	83,539	—	117,923 ^a	520	—	3,372	4,000
Crops	101,108	18,011	64,790	10,319	340	5,269	86,000
Agricultural processing	31,427	—	68,076	2,213	913	193	19,000
Manufacturing	6,287	38,982	34,377	377,952	42,875	31,470	150,710
Transportation, communication, and public utilities	14,261	11,476	19,840	110,309	69,265	8,252	66,870
Real estate, finance, and insurance	3,705	9,856	3,473	29,340	9,694	31,260	11,220
Services	2,620	8,691	17,995	64,037	26,297	14,102	74,410
Wholesale and retail	14,747	20,897	17,409	180,438	17,613	12,643	28,680
Mining	101	1,382	374	474,545	18,066	632	4,000
Construction							
Maintenance	1,650	2,659	1,205	2,805	25,614	7,824	95,000
New	3,739	6,024	2,011	27,015	34,955	21,284	2,600
Government							
Federal	837	2,161	10,308	37,510	91,757	31,392	8,000
State and local	12,372	16,286	7,426	40,698	35,925	4,965	3,280
Households							
Wages and salaries	11,047	26,953	66,000	330,000	242,000	102,000	230,000
Proprietor income	94,031	147,968	10,000	35,000	29,000	48,000	157,000
Rent income	3,458	20,642	1,602	17,884	14,439	13,946	36,900
Imports	6,336	18,090	24,283	177,955	21,247	14,668	74,400
Total	391,265	350,078	467,092	1,918,540	680,000	351,272	865,850

^a Dash indicates zero or negligible quantity.

The agricultural processing, manufacturing, and livestock and livestock products sectors have the largest output multipliers; the manufacturing, services, and agricultural processing sectors have the largest leakage coefficients. The greatest leakage occurs in the manufacturing sector, where the percentage of imports of manufactured products is large relative to the imports of the other sectors. The agricultural processing sector imports a considerable amount of manufactured products, as does the service sector. The livestock and livestock products sector has a relatively large multiplier but a small amount of leakage. It depends on imports less than do the industrial sectors. The multiplier and leakage coefficients for the remaining sectors are relatively small.

Income multiplier

The income multiplier for a sector measures the change in total income resulting from a one-dollar change in income in that sector. The income

Leakage and multiplier	Mining	Construction		Government		Households	Exports	Total
		Maintenance	New	Federal	State and local			
—	—	—	—	—	109	16,979	168,390	391,265
1,818	—	—	2,885	32,360	—	21,763	90,549	350,078
5,724	—	—	192	5,663	2,952	330,709	—	467,092
2,908	87,138	70,289	183,465	177,051	43,864	584,145	—	1,918,540
3,410	36,921	7,840	25,257	55,974	23,335	183,084	3,897	680,000
2,097	15,281	1,132	5,317	212	16,335	154,959	39,388	351,272
2,420	85,346	3,205	38,149	36,499	22,663	379,454	—	865,890
4,956	42,967	31,915	60,582	84,749	21,006	567,690	—	1,136,300
114	51,234	3,027	7,628	5,293	1,909	2,315	293,577	850,630
2,630	6,518	—	64	3,322	33,634	127,999	—	216,881
7,155	29,109	—	—	8,139	82,395	365,542	—	589,973
1,772	14,706	2,600	7,072	6,135	5,213	560,349	—	809,867
4,402	42,296	2,922	7,948	91,950	—	251,536	—	542,008
5,000	266,000	42,739	116,261	358,000	258,000	7,000	—	2,521,000
3,000	21,000	17,203	46,797	—	—	15,955	—	829,954
4,202	120,000	809	2,567	3,000	12,398	189,150	—	501,000
4,692	42,114	33,202	85,788	84,655	21,389	318,590	—	967,416
5,300	860,630	216,883	589,972	953,002	545,222	4,077,219	595,801	

multipliers computed from the original and modified interdependent coefficients and the leakage associated with each multiplier are presented in Table 6.

The agricultural processing sector has the largest income multiplier. The output of this sector depends heavily on imported packaging materials and equipment. The manufacturing sector has the second largest income multiplier and the largest amount of leakage. Most of the imports into the state are manufactured products used by the manufacturing sector itself. The income multiplier for the livestock and livestock products sector is ranked third; however, leakage in this sector is small. As with the output multipliers, the leakage coefficient for the services sector is ranked third, but it is much smaller than that for the industrial sectors. Industries in the services sector employ mostly local labor and thus most of the income earned remains in the state. The multiplier and leakage for the remaining sectors are somewhat similar. The small demand for imports and

Table 2. Modified interindustry flow table, Oklahoma economy, 1959^a

Activity	Livestock and livestock products	Crops	Agricultural processing	Manufacturing	Transportation, communication, and public utilities	Real estate, finance, and insurance	Services	Wholesale and retail	Mining
	92,570	117,000	117,000	thousands of dollars	thousands of dollars	thousands of dollars	thousands of dollars	thousands of dollars	thousands of dollars
Livestock and livestock products	101,108	18,011	64,790	10,319	340	5,269	866	1,818	—
Crops	34,997	—	75,856	12,480	1,020	246	21,214	6,363	—
Agricultural processing	8,966	56,843	50,451	553,883	63,415	45,759	221,268	131,882	127,326
Manufacturing	14,261	11,476	19,840	110,309	69,265	8,252	66,879	43,410	36,921
Transportation, communication, and public utilities	3,705	9,856	3,473	29,340	9,694	31,260	11,223	20,097	15,281
Real estate, finance, and insurance	2,677	8,879	18,389	65,424	26,860	14,402	76,025	94,426	87,184
Services	14,777	20,939	17,444	180,808	17,651	12,669	28,746	35,028	43,055
Wholesale and retail	101	1,382	374	474,545	18,066	632	433	114	51,234
Mining									

^a Dash indicates zero or negligible quantity.

Table 3. Interdependent coefficients, Oklahoma economy, 1959

Activity	Livestock and livestock products	Crops	Agricultural processing	Manufacturing	Transportation, communication, and public utilities	Real estate, finance, and insurance	Services	Wholesale and retail	Mining
Livestock and livestock products	1.3122	0.0014	0.3892	0.0029	0.0017	0.0151	0.0111	0.0035	0.0020
Crops	0.3774	1.0569	0.2851	0.0103	0.0028	0.0234	0.0110	0.0035	0.0031
Agricultural processing	0.1255	0.0024	1.2100	0.0060	0.0041	0.0046	0.0311	0.0096	0.0047
Manufacturing	0.1259	0.1838	0.2092	1.3453	0.1191	0.1574	0.2790	0.1422	0.1902
Transportation, communication, and public utilities	0.0920	0.0627	0.1132	0.1211	1.1327	0.0514	0.1248	0.0666	0.0824
Real estate, finance, and insurance	0.0332	0.0404	0.0327	0.0365	0.0230	1.1059	0.0264	0.0265	0.0300
Services	0.0480	0.0540	0.0919	0.1093	0.0647	0.0681	1.1276	0.1079	0.1406
Wholesale and retail	0.0986	0.0909	0.1100	0.1582	0.0486	0.0646	0.0762	1.0549	0.0450
Mining	0.0379	0.0547	0.0607	0.3574	0.0634	0.0451	0.0776	0.0395	1.1153

Table 4. Modified interdependent coefficients, Oklahoma economy, 1959

Activity	Livestock and livestock products	Crops	Agricultural processing	Manufacturing	Transportation, communication, and public utilities	Real estate, finance, and insurance	Service	Wholesale and retail	Mining
Livestock and livestock products	1.3181	0.0018	0.3992	0.0039	0.0021	0.0157	0.0131	0.0043	0.0026
Crops	0.3823	1.0581	0.2934	0.0126	0.0037	0.0247	0.0137	0.0067	0.0045
Agricultural processing	0.1438	0.0035	1.2415	0.0084	0.0052	0.0060	0.0367	0.0116	0.0062
Manufacturing	0.2243	0.3205	0.3753	1.6048	0.2106	0.2780	0.4912	0.2504	0.3335
Transportation, communication, and public utilities	0.1024	0.0752	0.1307	0.1448	1.1411	0.0629	0.1446	0.0768	0.0957
Real estate, finance, and insurance	0.0366	0.0445	0.0382	0.0440	0.0257	1.1187	0.0326	0.0298	0.0343
Services	0.0585	0.0667	0.1098	0.1336	0.0740	0.0803	1.1486	0.1196	0.1560
Wholesale and retail	0.1117	0.1073	0.1321	0.1894	0.0596	0.0795	0.1019	1.0680	0.1018
Mining	0.0641	0.0910	0.1050	0.4264	0.0877	0.0772	0.1340	0.0683	1.1539

Table 5. Output multipliers and leakage coefficients, Oklahoma economy

Activity	Multipliers ^a		Leakage ^b
	I	II	
Livestock and livestock products	2.25	2.44	0.19
Crops	1.55	1.77	.22
Agricultural processing	2.50	2.83	.33
Manufacturing	2.15	2.57	.42
Transportation, communication, and public utilities	1.46	1.61	.15
Real estate, finance, and insurance	1.54	1.74	.20
Services	1.76	2.12	.36
Wholesale and retail	1.46	1.64	.18
Mining	1.65	1.89	0.24

^a The multipliers in column I were computed from the original flow table and those in column II from the modified flow table.

^b Difference between multipliers in columns I and II.

Table 6. Income multipliers and leakage of the sectors in the Oklahoma model

Activity	Multipliers		Leakage
	I	II	
Livestock and livestock products	2.81	3.02	0.21
Crops	1.40	1.52	.12
Agricultural processing	4.32	4.92	.60
Manufacturing	3.35	4.01	.66
Transportation, communication, and public utilities	1.44	1.56	.12
Real estate, finance, and insurance	1.46	1.61	.15
Services	1.58	1.80	.22
Wholesale and retail	1.28	1.37	.09
Mining	1.57	1.72	0.15

the type of interdependences in these sectors determine the low leakage effect.

Employment multipliers

The employment multiplier as computed from the Oklahoma input-output model is defined as the change in the total labor force of the state due to a one-unit change in employment of a particular sector. The employment multipliers computed from the original and modified interdependent coefficients and the leakage associated with each multiplier are presented in Table 7. Multipliers are not computed for the crops and the livestock and livestock products sectors mainly because of underemployed resources and unused capacity, which are more of a problem in agriculture than in the other sectors.

Table 7. Employment multipliers and leakage of the sectors in the Oklahoma model

Activity	Multipliers		Leakage
	I	II	
Livestock and livestock products ^a			
Crops ^a			
Agricultural processing	2.82	3.35	0.53
Manufacturing	2.92	3.52	.58
Transportation, communication, and public utilities	1.42	1.62	.17
Real estate, finance, and insurance	1.52	1.71	.16
Services	1.32	1.44	.11
Wholesale and retail	1.32	1.40	.08
Mining	2.52	2.94	0.37

^a Employment multipliers not computed for basic agricultural sectors.

The manufacturing and agricultural processing sectors have the two largest leakage effects. The dependence of the activity of these sectors upon the imported manufactured products and the interdependences with other sectors explain the magnitude of the leakage effect. The mining sector has a relatively large leakage coefficient. The sector is labor-intensive, and in addition its operation is heavily dependent on manufactured products, many of which are imported. The remaining sectors, which are of the service type, have low leakage coefficients. The sectors are labor-intensive and most of the increase in employment occurs within the state.

Leakage Coefficient Versus Direct Import Coefficient

The leakage coefficient is a better measure of leakage than the direct import coefficient. The import coefficient, which is the amount of imports of a sector as a percentage of total input, are given in Table 8. The advantage of the leakage coefficient is that the interdependence among sectors is considered. Both direct and secondary effects are included in the

Table 8. Ranking of economic sectors by direct import coefficient, and output, income, and employment leakage coefficients

Activity	Direct import coefficient	Rank	Output leakage coefficient	Rank	Income leakage coefficient	Rank	Employment leakage coefficient	Rank
Manufacturing	0.093	1	0.42	1	0.66	1	0.58	1
Services	.086	2	.36	2	.22	3	0.11	6
Agricultural processing	.052	3	.33	3	.60	2	0.53	2
Crops	.052	4	.22	5	.12	7	—	—
Mining	.049	5	.24	4	.15	5	0.37	3
Real estate, finance, and insurance	.042	6	.20	6	.15	6	0.16	5
Wholesale and retail	.039	7	.18	8	.09	9	0.08	7
Transportation, communication, and public utilities	.031	8	.15	9	.12	8	0.17	4
Livestock and livestock products	0.016	9	.19	7	0.21	4	—	—

estimate, whereas only direct effects are included in the import coefficient. For example, suppose that the output of the agricultural processing sector is increased by one dollar. The import coefficient indicates that an additional five cents of products used by the agricultural processing sector will be imported. The leakage coefficient indicates that an additional 33 cents of total goods and services will be imported into the state. The difference is due to the increase in output in the other sectors as the output in the agricultural processing sector increases. Thus, the import coefficient is a weaker measure of leakage because it does not account for all ramifications of a change in an economy.

The main function of the leakage coefficient in relation to regional development and growth is to show the relative importance of imports for each sector of an economy. Sectors rank differently when the direct import coefficient and the three leakage coefficients are used (Table 8). The correspondence of the rankings is greater when the import coefficient is compared with the leakage coefficient for output than when it is compared with the other two leakage coefficients. The one sector which has the same rank by all four methods of ranking is the manufacturing sector; this result is due to the large absolute amount of manufactured imports. These different rankings show the disparity between the import coefficient and the leakage coefficient.

There is considerable variation in ranking among the leakage coefficients. This variation may be an important consideration for economic growth. If the object of an induced change is to reduce or eliminate leakage, the change may be made in different sectors; the choice of sector will depend on whether the leakage coefficient used is that for gross output, income, or employment.

Computation of Leakage Eliminating Imports of a Single Sector

In inducing regional growth and development, the objective may be to eliminate the imports of one sector or perhaps a group of sectors rather than those of all sectors at once. The same estimating procedure can be used to determine the change in the multiplier due to the elimination of imports into one or several sectors. For example, the amounts of agricultural processing goods and services imported by each sector might be subtracted from the entries in the import row and added to the corresponding entries in the endogenous portion of the table. Imports have been eliminated, one sector at a time, from each of the sectors with a positive net import figure in the Oklahoma model. The multipliers and leakage coefficients are shown in Table 9. Many entries are reported as zero because of rounding error. The horizontal sums of these leakages are the same as the total leakage given in Table 5.

As seen from Table 9, the largest change in the multipliers occurs when manufacturing imports are eliminated. This is to be expected, since the manufacturing sector imports by far the greatest amount of goods and services. If the object of regional development is the largest possible impact from eliminating imports, then the imports of the manufacturing sector will be eliminated. However, because of the integral nature of the total economy of the United States, it may not be practical or even possible to make the economy of the state self-sufficient in all manufactured products. Some industries that import goods into the state may be induced to build plants in Oklahoma, but certainly not all industries importing goods and services into Oklahoma will locate there.

Table 9. Output multipliers and leakage for sectors with positive net imports

Activity	Agricultural processing		Manufacturing		Services		Wholesale and retail	
	Multiplier	Leakage	Multiplier	Leakage	Multiplier	Leakage	Multiplier	Leakage
Livestock and livestock products	2.29	0.04	2.40	0.15	2.25	0	2.25	0
Crops	1.55	0	1.76	.21	1.55	0	1.55	0
Agricultural processing	2.56	0.06	2.75	.25	2.51	0.01	2.50	0
Manufacturing	2.15	0	2.56	.41	2.15	0	2.15	0
Transportation, communication, and public utilities	1.46	0	1.60	.14	1.46	0	1.46	0
Real estate, finance, and insurance	1.54	0	1.72	.18	1.54	0	1.54	0
Services	1.77	0.01	2.10	.34	1.77	0.01	1.77	0.01
Wholesale and retail	1.46	0	1.63	.17	1.46	0	1.46	0
Mining	1.65	0	1.88	0.23	1.66	0.01	1.65	0

The changes in the multipliers which result from eliminating services imports are small, as are the changes when wholesale and retail imports are eliminated. Imports by these two sectors are considerably smaller than imports by the manufacturing sector.

The leakages due to agricultural processing imports are also small compared to the leakages due to manufacturing imports. Part of the leakage occurs in the livestock and livestock products sector, which is one of the major sources of inputs for the agricultural processing sector. Few livestock products are imported into the state for processing, as shown by the small leakage coefficient. The importance of the agricultural processing sector to the economy of the state can be readily seen in the large multipliers and the small leakages. It would be advantageous to reduce, if not to eliminate, the agricultural processing imports.

The income and employment multipliers for no agricultural processing imports are shown in Table 10, along with the leakages. The leakages are relatively small. The greatest leakage for both multipliers occurs in the agricultural processing sector. Emphasis on reducing imports should be placed on industries in this sector.

Table 10. Income and employment multipliers and leakage with no agricultural processing imports

Activity	Income		Employment	
	Multiplier	Leakage	Multiplier	Leakage
Livestock and livestock products	2.85	0.04	—	—
Crops	1.40	0	—	—
Agricultural processing	4.42	0.11	2.89	0.07
Manufacturing	3.36	0.01	2.93	0
Transportation, communication, and public utilities	1.44	0	1.50	0.05
Real estate, finance, and insurance	1.47	0.01	1.55	0
Services	1.58	0	1.33	0
Wholesale and retail	1.28	0	1.32	0
Mining	1.57	0	2.56	0

Implications

The object of this study has been to show how the leakage associated with imports (that is, the reduction in multipliers resulting from imports) can be measured by an input-output analysis. The procedure was illustrated by an input-output model for Oklahoma. Leakage coefficients for output, income, and employment were computed for each endogenous sector. A comparison between the leakage coefficient and the direct import coefficient suggested that the former is a better measure of leakage than the latter.

A comparison of leakage coefficients by sectors permits an evaluation of the relative importance of imports to each sector of the economy. The ranking of sectors according to the effect of imports is an important use of the leakage coefficients. The coefficients also provide a measure of the gain in economic activity which results from eliminating imports. The coefficients can be computed by eliminating all imports, imports for a single sector, or imports for a group of sectors. This procedure allows a comparison of alternative plans to eliminate part or all of the imports of an economy. Though the procedure is not shown, the leakage coefficient can be estimated for the elimination of only part of the imports of a sector. This possibility might be important in, for example, estimating the impact of a new plant locating in a region.

Estimates of leakage provide decision-making information to individuals concerned with the problem of economic development and growth. They yield information about which sectors are affected most by imports and which are relatively unaffected. They provide information on the economic effect of a sector's becoming self-sufficient. With all this information, regional economists, regional planners, and others will be better able to evaluate the probable effects of various proposed programs on the

economy of a region. The leakage coefficients for each sector of a regional economy provide a helpful economic tool for formulating and implementing policies for regional development.

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Economics of Cost-Share Leases in Less-developed Countries*

DALE W ADAMS AND NORMAN RASK

Economists have long recognized that output-share leases result in inefficiencies in variable resource use. Cost-share leases have been suggested as a way of overcoming this inefficiency. Only in rare cases, however, has cost sharing become a part of share leasing in less-developed countries. It is argued in this article that in less-developed countries landowners generally make more net income by not adopting cost-share leases. The societal loss due to output-share leasing, and several policy alternatives, in addition to cost-sharing, which might help resolve this inefficiency problem, are discussed.

MANY less-developed nations still find share-leasing very prominent in major segments of their agricultural sectors. The inefficiencies in resource allocation which result from leases involving only output sharing were pointed out by economists as early as Adam Smith [7, pp. 366-372]. It has been shown that tenants with share-leases have incentives to combine a firm's resources in an efficient manner if variable costs to the firm are divided between tenant and landowner in the same proportion as output is shared [4, p. 600].

In the following pages we suggest an economic explanation of why output-share leases persist and why cost-share leases are not more common in less-developed countries.¹ We also try to identify the type of loss incurred by society through output-share leases. Some of the major policy implications of the analysis are covered in the final portion of the article.

Share-Leasing Reviewed

Except where noted, a 50-50 share arrangement will be assumed for the sake of simplicity in the following discussion. The analysis will also be restricted to one variable input and one product. For purposes of exposition, only two types of leases will be discussed: an output-share lease will be termed a "traditional lease" when all costs of the variable inputs are covered by the tenant, and an arrangement which requires the landowner to participate in variable input costs in the same proportion as he shares output will be termed an "ideal lease."

* We appreciate the comments of Kurt R. Anschel and Francis E. Walker on an earlier draft of this article. Valuable suggestions were also made by other colleagues at The Ohio State University and by the editors of this journal.

¹ To the best of our knowledge, cost-share leases are very rare in less-developed countries. For example, in several years of farm-level research in Colombia and Brazil, we found only a handful of share-renters who had any kind of cost-sharing arrangement with their landlords.

Several economic aspects of share-leasing can be demonstrated graphically in Figure 1. The line AQ_3 represents the marginal value product (MVP) of a firm. The firm's marginal factor cost (MFC) for a variable input (X_1) is depicted by BC ; the prices of the variable factor and product are assumed to be constant to the firm. An owner-operator would attempt to produce at the Q_2 level of variable input, where MVP equaled MFC for the firm. A tenant with a traditional 50-50 output-share lease would, however, perceive DQ_3 to be his marginal value product, that is, half of the firm's MVP . The line DQ_3 is, thus, equidistant from AQ_3 and OQ_3 , and the area in the triangles ODQ_3 and DAQ_3 are equal. Under a traditional lease, where the landowner pays none of the costs of the variable input, the tenant would maximize his profits by producing at the Q_1 level of variable input: the point where the firm's MFC is equal to half of the firm's MVP .

If the tenant and landowner adopted an ideal lease (output and vari-

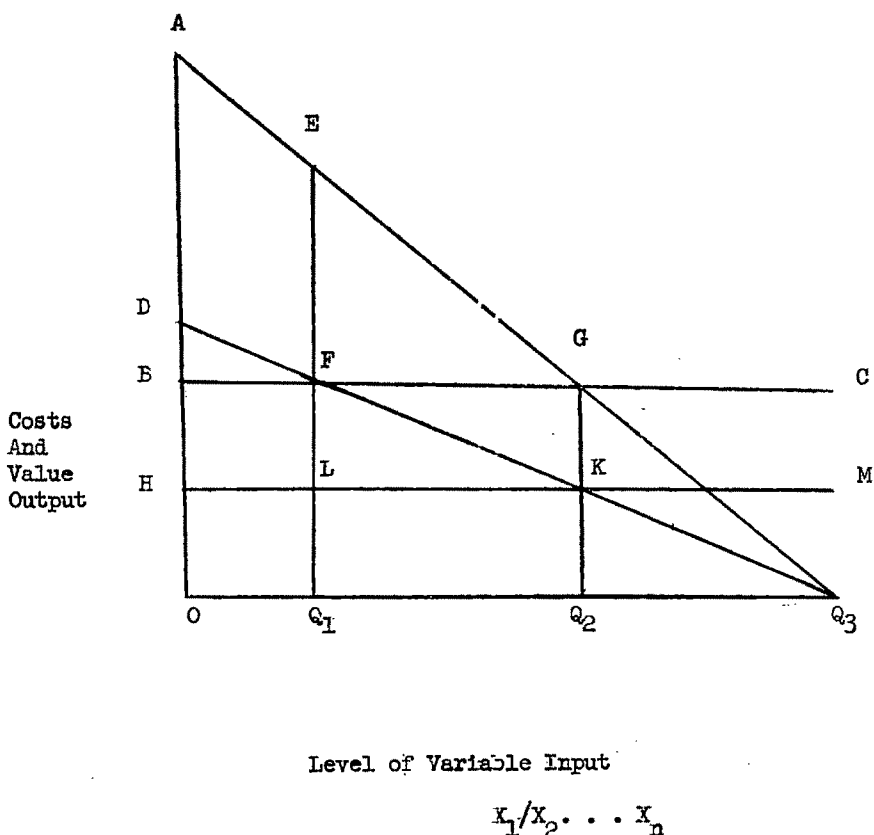


Figure 1.

able costs shared in the same proportion), the tenant would increase the use of the variable input to point Q_2 , where HM , his marginal factor cost (half of the firm's MFC), and his marginal value product (half of the firm's MVP) were equal. The adoption of an ideal lease would result in the application of variable inputs to the point where the firm's profits would be maximized with respect to the use of the variable input. The net return to the firm from using the variable input would be increased from $BAEF$ to BAG by discarding the traditional lease.

The Cost-sharing Puzzle

The lack of economic alternatives for rural labor in less-developed countries results in large numbers of tenant farms. Share-rental, in turn, is a popular form of tenancy since it distributes risks and uncertainties between tenant and landowner in a tolerable manner. The fact that most of these share arrangements do not include variable cost-sharing, even though total net returns to the firm could be increased by switching from a traditional to an ideal lease, presents an economic puzzle. Are the participants in the traditional lease economically irrational?

Again referring to Figure 1, we can see that the tenant would be willing, from an economic point of view, to adopt an ideal lease. The tenant's "economic rent" with respect to the use of the variable input would be equal to BDF under the traditional lease.² By adopting an ideal lease, the landowner would share in half the costs of the variable input, and the tenant would apply X_1 to the Q_2 level. With this type of lease, the tenant's economic rent with respect to the use of X_1 will be increased to HDK , an amount which will always be larger than the economic rent which he derived under the traditional lease. Other things being equal, the economic interests of the tenant would always be furthered by changing to an ideal lease.

The economic results of the change for the landowner are less clear-cut. The landowner's participation in variable costs of X_1 under a traditional lease is nil. But, as is shown in Figure 1, if the landowner switches to the ideal lease, he must incur additional costs equal to the rectangle $HBGK$: his half-share of the total costs of X_1 . The area $HBFL$ is equivalent to an income transfer from the landowner to the tenant, and the area $LFCK$ is the landowner's share of the costs of producing the additional output Q_1EQ_2 . In return for these new costs, the landowner would receive additional output equal to the trapezoid $FEGK$. Unless the area of the additional-output trapezoid is larger than the cost rectangle ($HBGK$), it would not be in the economic interests of the landowner to change from a traditional to an ideal lease.

² *Economic rent* is used in the sense that it is an output or payment in excess of the minimum supply price needed to keep a factor in its present use.

Given the production function for a firm, the factor and product prices which it faces, and the tenant-landowner share arrangement, a general expression can be derived to determine the conditions under which a landowner would profit by switching to an ideal lease. Again referring to Figure 1, we define HB/OB as the landowner's share, and OH/OB as the tenant's share of output and/or variable costs. We specify that if $FEGK > HBGK$, the landowner will profit by adopting an ideal lease. $FEGK = \frac{1}{2}(FE \cdot Q_1Q_2) + \frac{1}{2}(HB \cdot Q_1Q_2)$, but $FE = (HB/OH \cdot Q_1F)$, and $Q_1F = OB$; therefore, $HB/OH \cdot OB = FE$. Thus, $FEGK = \frac{1}{2}(HB/OH \cdot OB \cdot Q_1Q_2) + \frac{1}{2}(HB \cdot Q_1Q_2)$, and $HBGK = (HB \cdot OQ_1) + \frac{1}{2}(HB \cdot Q_1Q_2) + \frac{1}{2}(HB \cdot Q_1Q_2)$. Simplifying, if $HB/OH \cdot OB \cdot Q_1Q_2 > 2(HB \cdot OQ_1) + (HB \cdot Q_1Q_2)$, the landowner will profit by adopting an ideal lease. Setting $OB = OH + HB$ and further simplifying the inequality results in $HB/OH > 2OQ_1/Q_1Q_2$. But HB/OH is the ratio of the landowner's share of output to the tenant's share of output. Therefore, if this ratio is greater than twice the proportion of the level (OQ_1) of input of X_1 under the traditional lease, to the change (Q_1Q_2) in use of the variable input under an ideal lease, the landowner will be economically justified in adopting an ideal lease.³

Under a 50-50 share arrangement, we see that the landowner would have economic incentives to adopt an ideal lease only if $Q_1Q_2 > 2OQ_1$. If, for example, the tenant receives three-quarters of the output and the landowner one-quarter, $Q_1Q_2 > 6OQ_1$ must be realized. Other things being equal, the landowner who receives a small share of output will be more likely to benefit economically from an ideal lease than a landowner who receives a large share of output. A relatively "flat" MVP curve for the firm, and low levels of variable input under a traditional lease, would be necessary to satisfy these conditions.

Empirical evidence would, of course, be necessary to establish the numerical importance of landowners who would realize less net returns by adopting ideal leases. The fact that few ideal leases are used in less-developed countries is compatible with our assertion that most landowners face a set of conditions which make traditional leases more profitable for them than ideal leases. Except in a few cases, the economic interests of the landowner are probably the major factor in explaining the persistence of traditional share-leases.

Social Loss Associated with Traditional Share-Leases

There are several sources of economic loss incurred by society as a result of traditional share-leases. The first and most obvious loss can be

³ Some readers may want to verify through the use of calculus the geometric results presented in this paragraph.

shown in Figure 1. When the tenant is only applying Q_1 of X_1 , the *MVP* to society of the last unit applied exceeds the *MFC* for society by *FE*. An increase in the use of X_1 to Q_2 would result in the firm's operating at the point where *MFC* equalled *MVP*, and this would increase the net total value product, with respect to the use of X_1 , by an amount equal to *FEG*. The area *FEG* represents the opportunity lost by society because a traditional rather than an ideal lease is used in a single firm.⁴

Still further social loss may result from the firms (or potential firms) which are economically blocked from using *any* of a variable input because of a traditional share-lease. Again referring to Figure 1, we see that some tenants may find that the *MFC* for a variable input (represented by *BC*) is greater than half of the firm's *MVP* (DQ_3) at all possible levels of application of X_1 . Some forms of new technology and mechanization, for example, may not be used by a 50-50 share-tenant because the firm's *MVP* is less than twice *MFC* at all possible levels of production.⁵ It may be, however, that the *MFC* of the variable input is less than the firm's *MVP* over some range of use of X_1 , and that an owner-operator or a tenant with an ideal lease would have economic incentive to apply some of the variable input. Where this set of circumstances occurs, the area circumscribed by the vertical axis, the *MFC* line (*BC*), and the firm's *MVP* line (AQ_3) represents the potential net value product which society loses because of the production block placed by traditional share-leases.⁶

Exploitation of Tenant

All traditional leasing arrangements, in a sense, contain an element of exploitation. That is, the tenant receives a smaller net return under the traditional lease than he would with an ideal lease. In addition, several specific elements of tenant exploitation are often associated with traditional leasing arrangements.⁷

As was suggested earlier in discussing Figure 1, the tenant with a traditional lease will want to apply only Q_1 units of X_1 . The landowner, how-

⁴ Summing the areas similar to *FEG* for all of the firms with traditional leases and calling this the total social loss would tend to overstate the real loss. In aggregating units, the assumptions regarding constant prices for the products and factors of production would likely be nullified.

⁵ This same point is also made by Castle [3].

⁶ The magnitude of the possibilities of increasing input utilization and thus agricultural output by eliminating traditional share-leases has been treated by some studies [1, 6, 8]. In most cases, the increases in the application of variable inputs associated with changes in traditional leasing arrangements are substantial.

⁷ D. Gale Johnson [5, p. 116] has pointed out that if share-tenants have free access to land they will exploit the landowner by renting additional land until its marginal value product is zero. In most less-developed countries, landowners protect themselves from this type of exploitation by sharply restricting the amount of land which a share-tenant is allowed to operate.

ever, would like to see Q_3 units applied. The distance between Q_1 and Q_3 demarcates an area of possible conflict. Under certain circumstances the landowner may be able to force the tenant to apply more than Q_1 units of the variable input. If we assume, for example, that the labor of the tenant and his family is represented by X_1 , the landowner under semi-feudalistic tenure systems may be able to force the tenant to expend more than Q_1 units of labor. He would do this by requiring the tenant to provide an extra fixed amount of labor to the landowner as a requisite for receiving the parcel of land. The tenant or a member of his family might be required to provide several days of work per month to be used at the landowner's discretion. Referring again to Figure 1, we see that the tenant may be willing to give the landowner labor beyond Q_1 as long as the additional disutility of the work past Q_1 is less than the tenant's utility of the economic rent (BDF) which he receives from labor on his tenant farm. This is one method which a landowner has of "taxing away" the tenant's economic rent from labor.

Another type of exploitation may occur when tenant families are producing an output which is only slightly above that needed to meet some minimum-income target. For illustrative purposes, we define $ODFQ_1$ to be this amount of output. We further assume that the number of people in a general area who want to become tenants is increasing, that there are few opportunities outside of traditional share-rental arrangements for this growing population to make a living, and that tenants accept a smaller share of output in order to obtain the opportunity of earning a living through tenant farming. The tenants would thus bid down their share of output and lower point D in Figure 1 toward O . In order to maintain the minimum-income target $ODFQ_1$, the tenant would be forced to lower the reservation price of his family's labor (BC) until it intersected his new marginal value product line at a point where target income was met. This would result in more labor than Q_1 being applied to the production process by the tenant, and in a sense the tenant would be exploited over the original arrangement; he would receive the same amount of output but would expend more labor. The landowner would receive additional output equal to the total increase in the production of the firm.

The landowner could achieve the same results by dividing his ownership unit into smaller parcels so that more tenants could be included. Each tenant would have less land to combine with his labor. For each of the tenants this would have the effect of shifting AQ_3 and thus DQ_3 to the left in Figure 1. To maintain a minimum-income target, tenants might be forced to apply more labor to their smaller units. Again, the tenant may be able to achieve the same level of income, but he has been forced to apply more labor. Other things being equal, the landowner would receive more total output from the larger number of smaller units.

Policy Implications

Since landowners generally cannot profit from adopting cost-share leases, some type of societal pressure will be required to induce them to participate in variable costs. Cost-share arrangements for certain types of variable inputs, for example, could be made legally mandatory.⁸ Passing a law, however, is generally easier than enforcing it. Additional pressure would likely be necessary to force landowners to consider cost-share leases seriously. Such things as legal assistance to tenants who were attempting to force landowners to comply with the law might be one form of additional pressure. Since landowners might opt to terminate all leasing arrangements, if allowed this alternative, caution would have to be used in applying such coercion.⁹

Indirect pressure can also be applied by long-run programs which improve share-tenants' economic alternatives. With a scarcity of tenants, landowners may be forced either to reduce their portion of output or to share in some variable costs. In the United States, at least, substantial rural out-migration and the rapid growth in off-farm employment opportunities are important elements in explaining the increase in the number of cost-share leases. The additional economic inducement for tenants which cost-sharing provides has been necessary to attract labor into leasing arrangements in the United States.

To this point we have emphasized cost-share leasing as a method of encouraging tenants to utilize variable inputs in socially efficient amounts. At least three other plausible policy alternatives might also be considered: (1) switching share-rentals to fixed rentals, (2) changing tenants to owner-operators, and (3) forcing tenants to act against their own economic interests through pressures exercised by short rental periods.¹⁰

Fixed rentals could provide tenants with incentives to allocate variable resources efficiently within their firms. There is some indication that fixed rents become more common as tenants attain some measure of affluence. Most share-tenants in less-developed countries, however, are too impoverished to tolerate the economic risks and uncertainties associated with agricultural production under fixed rentals; tenants would likely object to fixed rents more strenuously than landowners. For tenants with fixed rentals and small economic bases, the marginal disutility of a decrease in income may far exceed the marginal utility of a similar increase in income.

⁸ Additional legislation to force a reduction in the share of output received by the landowner would also reduce the inefficiency in variable factor use. Viewed in this way, rent reduction as a first step in land reform programs in countries like Japan and Taiwan had a firm economic as well as a welfare justification.

⁹ As pointed out by Barraclough and Domike [2, p. 413], thousands of small tenants have been evicted by landowners in Latin-American countries as a direct result of various tenancy laws.

¹⁰ This last method has been suggested by Johnson [5, p. 118].

Making owner-operators out of tenants through land reform programs is another technique for eliminating share-tenure inefficiencies. Other things being equal, share-renters would have incentives to apply more variable inputs to their units as owners. Most share-renters have developed managerial skills. This fact, plus the additional output which can be expected through eliminating traditional leases, suggests that land reform in areas with concentrations of traditional share-renters should be assigned a high priority. Unfortunately, landowning interests can be very effective in blocking these types of programs.

Short-term leases undoubtedly exert pressure on share-tenants to apply variable inputs beyond the point which their marginal economic considerations would dictate. A tenant may be forced to do this in order to avoid the costs associated with changing locations. Despite this positive influence exerted by short-term leases, the disincentives to land improvement and other long-term investments probably outweigh this consideration.

In most countries, a good deal more information is needed on share-rental arrangements in order to select among alternative policies. More data are needed on the numerical importance of traditional share-leases in less-developed countries. Research is also needed on the numbers of landowners who could not profit by adopting cost-share leases. Additional investigation on the size of the production increase which might be expected by eliminating the disincentives to use of variable resources would also be useful. These types of research would help in assessing the influence of share-tenure inefficiencies on variable resource use and also help identify techniques, in addition to cost-sharing, which might help solve this problem.

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An Empirical Study of the Agricultural Labor Market in a Developing Country, Brazil*

RUSSELL YOUMANS AND G. EDWARD SCHUH

Underemployed agricultural labor implies a poorly functioning labor market. The allocative efficiency of the labor market in the Brazilian state of Minas Gerais is evaluated by estimating agricultural production functions for five regions within the state, estimating the MVP of labor, and comparing this with the MVP of labor in other regions and other sectors of the economy, and with wage rates in both the farm and the nonfarm sectors. The results indicate that labor adjustments are taking place, but not at a fast enough rate to establish equilibrium. Considerable opportunity was found for reallocating labor within the agricultural sector. Surprisingly, in some of the regions the MVP of agricultural labor was greater than the wage rates in the nonfarm sector. Little or no correlation was found between the degree of industrial-urban development and the performance of the labor market.

TWO factors give cause for concern about the market for agricultural labor in a developing country. First, the hypothesis that underdeveloped countries have significant amounts of underemployed labor in their agricultural sectors is prevalent in the literature on economic development.¹ Much of this literature regards underemployed labor as a potential source of economic growth if it can be effectively mobilized by the economy.² Second, because a developing country experiences change, there may be considerable distortion in the efficiency of resource use. Self-sustaining growth requires that available resources be employed where they make their largest contribution to production at the margin and that resource owners receive the value of the marginal contribution of their resources in the production process.

The Brazilian economy has experienced relatively rapid growth for at least a decade and a half. Gross National Product expanded at a rate of 8 percent per year during the 1950's, and the rural population as a percentage of the total population declined from 64 percent in 1950 to 55 percent in 1960. With changes such as these, labor, as well as other resources, may be seriously misallocated.

This article reports the findings of a study designed to estimate the extent to which the market for agricultural labor in Brazil is performing its allocative function.³ The basic premise of the study is that labor is not

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being efficiently utilized in the Brazilian economy but that misallocation may involve much more than the common notion that labor has zero marginal productivity in agriculture. The analysis involves an estimation of the marginal value product of agricultural labor in five selected regions of Minas Gerais, a state important to Brazilian development, and a comparison of these MVP's with wage rates and marginal value products in alternative employments.

The Statistical Model and Data

The basic manifestation of a resource allocation problem is a resource's having a lower marginal value product in its present use than it would have in an alternative use. If labor markets are perfect in the sense that the labor receives its marginal value product, a comparison of the MVP's among alternative uses (which could be a farm, a region, or an industry) will provide evidence on the efficiency of resource use. Comparison of the MVP with the wage rate paid will further aid in evaluating the performance of the market.

The basic statistical problem of the study was to estimate for five selected regions the parameters of the production functions which could be used to estimate the marginal productivity of agricultural labor. The same model was used for each of the regions.

The underlying production function was assumed to be of the Cobb-Douglas⁴ type, and was estimated by ordinary least squares. The production function was specified as follows:

$$\log Y = \log \alpha + \beta_1 \log X_1 + \beta_2 \log X_2 + \beta_3 \log X_3 + \beta_4 \log X_4 + \beta_5 \log X_5 + \log u$$

where

Y is gross income, measured in *cruzeiros*,

X_1 is labor, measured in man-month equivalents of labor used,

X_2 is cultivated land, measured in hectares,

X_3 is pasture land, measured in hectares,

¹ Underemployed labor is an economic concept which has been given many names and definitions. For a review and evaluation of these, plus related empirical studies, see Kao *et al.* [7], Kenadjan [8], Liue [11], Paglin [13], and Schuh [15]. Rationalizations for the existence of underemployed labor may be found in Leibenstein [9], Lewis [10], and Nurkse [12].

² Models which provide insights into the means of making more effective use of underemployment labor may be found in Fei and Ranis [3], Lewis [10], and Nurkse [12].

³ There are several recent empirical studies of the problem of underemployed labor [1, 5, 13, 14, 16, 19].

⁴ Quadratic, square root, linear, and Cobb-Douglas forms were all estimated with the sample data from the *município* of Uba. The significance of the parameter estimates, the signs of the coefficients, the size of the coefficient of determination, and the computational ease led to selection of the Cobb-Douglas form for our equations.

X_4 is capital services, measured as a flow in *cruzeiros*,

X_5 is operating costs, measured in *cruzeiros*,

β_i are structural coefficients ($i = 1, 2, \dots, 5$) which are the elasticities of production,

α is the constant term, and

u is a random error term about which the usual assumptions are made.

All input variables attempt to measure the *flow* of services used as contrasted to the *stock* of resources available.⁵

No attempt was made in the estimation to achieve a "best" fit by re-computing variables and/or re-estimating the equations. The data were edited from the questionnaires to assure consistency in the definition of the variables, but no adjustments were made in the variables after the original estimations were made. It should be noted also that considerable aggregation of inputs within the firms was necessary in order to permit interregional comparisons.

Data used in estimating the production functions were taken from previous production function studies made at the Institute of Rural Economics of the Rural University of Minas Gerais, Brazil [6, 17, 18, 20, 21]. Each of these studies was based on approximately 100 questionnaires filled out in direct interviews with farm operators. The samples were randomly drawn from property-tax lists of landowners and were stratified by farm size on the basis of hectares. The number of strata varied from five to seven, depending on the range in size, and equal numbers of observations were taken in each stratum. For purposes of the present study the variables were redefined in order to provide uniformity of definition among the several regions.

The five samples used were taken over a three-year period, 1961-1963, with three having been taken in 1962. For some of the analyses which follow, the data had to be adjusted to a common base because of the high rate of inflation in Brazil. Because of the lack of suitable data, we decided to make this adjustment in the estimated wage rates and MVP's rather than in the original estimation of the production function.

Areas Studied

The study concentrated on five areas of Minas Gerais, an important agricultural state in Brazil.⁶ The areas selected allowed us to test a number

⁵ A discussion of sampling procedures, the data series used, and a more detailed description of the data series are available from the authors in mimeographed form.

⁶ The state of Minas Gerais is larger in area than France and has a population larger than that of any country in Latin America except Brazil and Argentina. In development it is intermediate between the highly developed state of São Paulo and the low-income states of the northeast. The population tends to be distributed along the southern and eastern borders of the state, a distribution which is reflected in our selection of *municípios*.

of hypotheses about institutional and economic forces which might influence the functioning of the labor market.

The regions studied (Fig. 1) are as follows:

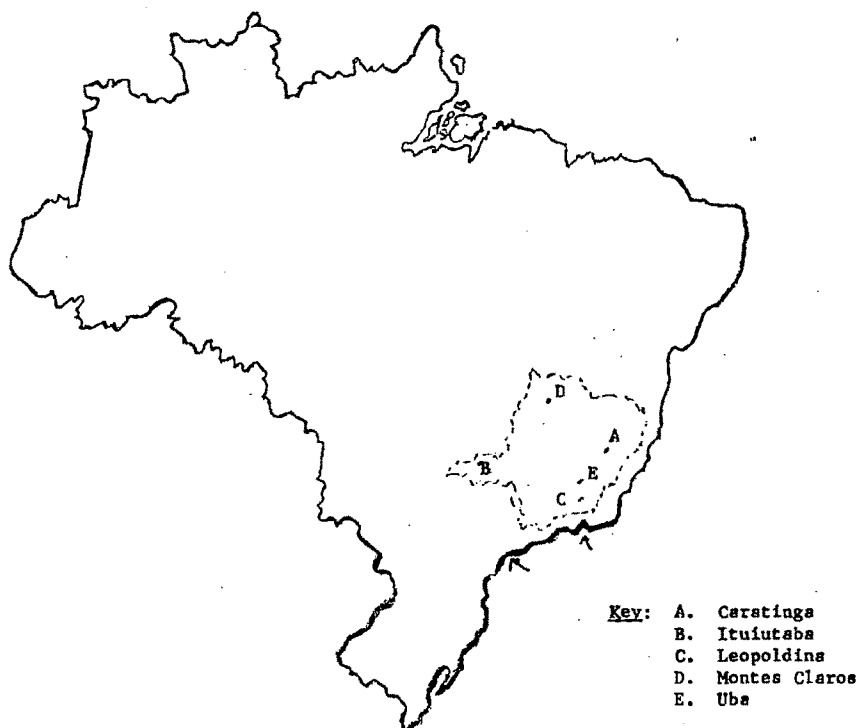


Figure 1. Location of the areas selected for study, Minas Gerais, Brazil

Uba has in many respects a "traditional" agriculture. It is also relatively isolated from the general economy, and although it has a small industrial sector, this does not provide substantial employment alternatives. Farms tend to be small, and the major commercial product of agriculture is tobacco, a labor-intensive crop.

Caratinga is intermediate in its development between traditional and modern agriculture. Many of the farmers use traditional methods, but some use relatively modern technology. A paved road connects the area to the markets in the south, which facilitates the mobility of both products and people, despite the fact that the distances are rather great. The farms are a little larger than those in Uba, and the livestock enterprises are growing rapidly.

Ituiutaba is one of the most promising and most rapidly developing agricultural areas in both Minas Gerais and Brazil. The agriculture is more

commercially oriented and much more highly mechanized than in other areas of the state. The factor and product markets are relatively well developed, and the region is reasonably well integrated into the general economy. This region is, however, intermediate in its labor intensity, despite its high mechanization. The type of farming is general, livestock-grains, and the farms tend to be very large.

Leopoldina was selected chiefly because of its proximity to the markets of Rio de Janeiro and São Paulo and its relatively labor-intensive dairy enterprises. A paved road provides easy access to the market for fluid milk in Rio de Janeiro and São Paulo. Although the dairy enterprises are highly commercial, the agriculture tends to use a comparatively traditional technology.

Montes Claros was selected as a relatively new area in the drier northern part of the state. Distance and lack of roads make the region more isolated than the other areas, although a railroad provides market opportunities for the large quantities of cattle produced. The agriculture of this area is primarily a very extensive grazing system of beef production.

Statistical Estimates of the Production Functions

The statistical estimates of the production functions are presented in Table 1. The R^2 's are reasonably high, with the exception of the function for Caratinga, and the number of coefficients that are either significantly different from zero or greater than their standard errors is reasonably large.

A summary of the statistical results follows:

1. Labor has a positive coefficient in all five regions, and the coefficient is significantly different from zero in three of these. Of the remaining two, the coefficient is larger than the standard error in Caratinga, but considerably smaller than the standard error in Leopoldina.

2. The coefficient for cultivated land is positive and significantly different from zero at the 10-percent level or better in each of the three regions in which it appears.

3. The coefficient for pasture land, on the other hand, is negative in two regions and positive in two regions. It is significantly different from zero in only one region, however, and is quite small in two others. It may be that the pasture-land variable, as measured, has very little relation to production. If, because of the high rates of inflation, farmers invest heavily in land to protect their assets, and yet farm only a part of this land, a large fraction of what is reported as pasture land may well be merely idle land. This supposition seems plausible in at least Caratinga and Ituiutaba, although the variable would be expected to contribute more in Leopoldina, the dairy region. In the latter case, the nearness to an urban area may have led to speculative purchases of land. In Montes Claros, the cat-

Table 1. Parameters and standard errors for the Cobb-Douglas production functions, estimated for the five selected areas, 1961-1963^a

Area	Regression coefficients and standard errors					Constant	Sum of regression coefficients	R ²
	Labor X_1	Cultivated land X_2	Pasture land X_3	Capital services X_4	Operating costs X_5			
Uba n = 70	0.76420** (0.16344)	0.28166* (0.16309)		0.03290 (0.08312)	0.07815 (0.13266)	1.07523	1.07523	0.820
Caratinga n = 73	0.25850 (0.21823)	0.28815** (0.13770)	-0.11895 (0.11288)	0.29673** (0.12640)	0.08591 (0.11884)	1.29788	0.81034	0.443
Ituitaba n = 98	0.58935** (0.09985)	0.14388** (0.03884)	0.00094 (0.07134)	0.12409* (0.06790)	0.27169** (0.06910)	1.12909	1.12995	0.815
Leopoldina n = 65	0.02922 (0.11534)		-0.01044 (0.13712)	0.92422** (0.18234)	-0.02920 (0.04929)	0.46667	0.95468	0.671
Montes Claros n = 80	0.19807** (0.05806)	0.29823** (0.05436)		0.24680** (0.05217)	0.31037** (0.04931)	1.28166	1.05347	0.865

^a One asterisk indicates that the regression coefficient is statistically significant at the 10-percent level and two asterisks that it is significant at the 5-percent level. Two-tailed tests are relevant.

tle-grazing region, the variable does have a statistically significant coefficient.

4. The coefficient for capital services is positive in all five regions and significantly different from zero at the 10-percent level or better in four.

5. The coefficient for operating costs is positive in all regions except one, although it is significantly different from zero at the 5-percent level in only two. In each of the other three regions the standard error is larger than the estimated coefficient. The coefficient for operating costs is positive and significantly different from zero in the two regions which have grown most rapidly in recent years. These costs reflect largely the introduction of new techniques such as ration supplements, fuels, fertilizer, and veterinary care. In Uba, Caratinga, and Leopoldina, which are more traditional in their organization, these variables do not have significant coefficients.

Since the estimated coefficients for labor will serve as the basis for much of the analysis which follows, an additional point about them is worth noting. There is considerable range in the size of the coefficient (0.198 to 0.764) even among those which are statistically significant. This adds some plausibility to the estimates, for Uba, with a high coefficient (0.764) is a region in which the product—tobacco—is labor-intensive, whereas Montes Claros, with a low coefficient (0.198) is a region where the product—beef cattle—is labor-extensive. Ituiutaba, a general farming area, occupies an intermediate position, with a coefficient of 0.589.

Performance of the Labor Market

In this section the estimated MVP's of labor, together with wage rate and other data, are used to evaluate the performance of the agricultural labor market.

Labor with a zero marginal productivity

The frequent definition of underemployed labor as labor with a zero marginal productivity can be examined by means of the production functions given in the preceding section. An estimated coefficient for labor that is not significantly different from zero implies that the marginal productivity of labor is equal to zero. That is, it suggests that additional increments of labor in the region would not increase agricultural output.

Using this criterion, we can reject the null hypothesis of zero marginal productivity for labor in three of the five regions studied (Table 1). The coefficient for labor is significantly different from zero at usually accepted levels in the production functions for Uba, Ituiutaba, and Montes Claros. It is not significantly different from zero in the production functions for Caratinga and Leopoldina; hence, the null hypothesis of zero marginal productivity cannot be rejected in these two regions.

Therefore, on the basis of the zero marginal productivity definition, only two of the five regions studied have underemployed labor. One of these, Leopoldina, is reasonably close to urban industrial centers and involves an agriculture that is reasonably well integrated into a market economy. The other, Caratinga, is a relatively isolated region that is in the process of adjustment from the labor-intensive production of coffee to a more labor-extensive, general type of farming.⁷

In either case, it is not possible to say over what range the marginal productivity of labor would be zero. Presumably, a reduction in the use of labor, if other inputs were held constant, would raise the marginal productivity of labor as the law of variable proportions came into play. But no statistical test is possible which would provide insights into the order of magnitudes involved in this.

A comparison of the marginal value product of labor and the agricultural wage rate

The existence of underemployed labor in a given region or industry implies a factor market that is not performing perfectly. By definition, a perfect labor market is one in which the input receives as a wage the value of its marginal product and this in turn is equal to its opportunity cost. One part of the test for the performance of the labor market is, therefore, to determine whether labor is receiving the value of its marginal product.

Statistical comparisons were made between the reported wage rate and the value of marginal product of labor at the geometric means of the sample for each of the five regions (Table 2).⁸ It is interesting to note that for each of the two regions where the value of marginal product is not significantly different from zero (Caratinga and Leopoldina) it is also not significantly different from the reported wage rate in the region, although it is less than the wage rate. However, for each of the other three regions, where the value of marginal product is significantly different from zero, it is also significantly different from the reported wage. And further, the value of marginal product is greater than the wage rate. That is, labor is receiving less than the value of its marginal product in these three regions.

Barring the possibility of measurement error⁹ or bias in the estimated

⁷ Each of these two *municípios* lost population in the decade of 1950-1960. This fact suggests that they may be subject to long-run secular declines or changes in their agricultural sector, and that, although there has been adjustment in the labor force, it has not been large enough to bring the labor force into equilibrium.

⁸ A description of the test is given in Heady and Dillon [4, pp. 578-582].

⁹ At this point a few comments on the data are in order. In the first place, the failure to obtain a significant coefficient for labor in the two regions may be a result either of sampling variability or of measurement errors in the data. It is not possible to determine whether either of these is happening. An additional possible source of

Table 2. Statistical comparison between wages and marginal value products in five *municípios* in the state of Minas Gerais, Brazil, 1961-1963^a

<i>Município</i>	MVP ^b	Reported wage ^c
	..... <i>thousands of cruzeiros</i>	
Uba (1961)	8.5**	2.7
Caratinga (1962)	2.0	3.1
Ituiutaba (1962)	19.0**	6.0
Leopoldina (1962)	0.8	5.3
Montes Claros (1963)	72.2**	10.6

^a Two asterisks indicate a difference that is statistically significant at the 5-percent level.

^b Evaluated at the geometric means of the variables.

^c Test made on the null hypothesis that the MVP and the reported wage were equal.

production functions, the high MVP's in relation to reported wages may be explained at least two different ways. (1) Farm operators may be hiring labor in a competitive market but, through lack of knowledge about labor's contribution to production, may not be using an adequate amount of labor.¹⁰ On this interpretation, farmers could profitably hire more labor (paying a higher wage if necessary), thereby increasing their own net incomes and at the same time increasing employment opportunities for the labor force. (2) Farmers may be monopsony buyers of labor because of the lack of alternatives for the labor force, and hence may be exploiting laborers by not paying them the value of their marginal product.

It is not possible to determine from the data at hand which of these is the true situation. However, in each region there is a relatively large number of landowners, and it does not appear that they are colluding to keep wages down.

Of the three regions which had MVP's for labor that were significantly higher than the going wage rate, two have rapidly expanding, dynamic agricultural sectors. The population of Montes Claros increased 26 percent between 1950 and 1960, the decade preceding the period of study. Ituiutaba had a very low growth rate in population for the same decade, but its agriculture is developing rapidly. Uba does not have the growth or dynamism of either of the other two regions.

error is in the data on wage rates. On the questionnaires, in response to direct questions about wages, farmers reported that laborers in Minas Gerais receive payment in at least three forms: (1) a share of the crop, (2) cash, with meals furnished, and (3) cash without meals. The wages used in this study were of the third type, since it appears to be the most commonly used. We believe that the reported wages are a reasonably valid estimate of the price of labor. If there is a bias, it is upward, since farmers may be inclined to overestimate or overreport wages paid.

¹⁰ This would be especially the case if the production function shifted a great deal from year to year because of fluctuations in weather. In such cases, the ex post resource allocation may almost always be wrong.

Interregional comparisons

Underemployed labor is defined as labor which is contributing less in its present employment than it could contribute in alternative employment or receiving less than it could receive in alternative employment.¹¹ In this section, the analysis is made in terms of alternative employment in agriculture. The question posed is whether labor could be taken from its present employment and transferred to another region, thereby increasing total production and in addition increasing the income of the transferred labor.

The analysis will proceed by comparing each of the five regions with each of the others. For such a comparison to be possible, the values of the marginal products and the agricultural wage rates, which are given in monetary terms, have to be adjusted to a common base. Of the five samples used in the analysis, three were taken in 1962, one in 1961, and one in 1963. The MVP's and wage rates for Uba (1961) and Montes Claros (1963) were adjusted to a 1962 base by the use of a cost-of-living index which is assumed to be representative of the nation as a whole. It is recognized that such an adjustment carries a heavy load of assumptions,¹² but it is made in order that the analysis can proceed on as broad a base as possible; in any case, there is no practical alternative.

¹¹ Strictly from a resource allocation standpoint, if the markets were performing perfectly in the sense that labor was receiving the value of its marginal product, only the first criterion would be relevant. Since the analysis indicated that labor in agriculture was not receiving the value of its marginal product, both criteria are used here. The second criterion is perhaps more relevant from the standpoint of the individual worker, since what he would receive in alternative employment would be the current wage rate and not the value of his marginal product in that employment.

¹² The assumptions involved in such an adjustment are (1) that the price index used is representative for each of the regions, (2) that the values of the marginal products in real terms are not subject to large year-to-year variations, and (3) that labor market conditions were reasonably stable from year to year in the three years of study. The fact that inflation has become almost a way of life in Brazil makes the first assumption plausible. Since weather conditions were not "unusual" in any of the regions in the years when the data were collected, the second assumption also seems plausible. Lack of data prevent an evaluation of the plausibility of the third assumption; but given the fact that neither the agricultural sector nor the general economy were subject to serious short-run instability in this period, it can be assumed that labor market conditions did not change substantially from one year to the next. In addition it is assumed that there are no substantial differences in the cost of living among the five regions, so that the money value of the MVP's and the wage rates can be compared directly. This is a plausible assumption so long as one agricultural region is being compared with another, with the possible exception of Leopoldina, which is in a somewhat more commercialized area. A final assumption is that labor transferred from one region to another would have the skills necessary to make the same marginal contribution in the production process as the labor already present in that region. Although farming differs substantially among the five regions, ranging from the production of tobacco to the extensive grazing of cattle, the labor used is still considered to be essentially unskilled.

Comparison of the MVP's among regions

The MVP's for labor in the several regions, adjusted for price-level changes from year to year, are presented in Table 3. It can be seen that they differ substantially among the several regions, with large differences even among the three samples that were taken in the same year. These differences among regions may be the result of sampling variability. Hence, we must ascertain whether the differences indicated are statistically significant, using the coefficients of the production function [4, p. 581].¹³ The results of this test, with the coefficient for each region tested against that for each of the others, are summarized in Table 4. The coefficients presented in the table are those necessary to equate the MVP's for

¹³ For example, in comparing the marginal productivities between Region A and Region B, we compute the coefficient for labor in the production function for Region A which would produce the same MVP for labor in Region A as exists in Region B. Using this value as a null hypothesis, we use the *t*-test to determine whether the computed coefficient is significantly different from the estimated coefficient.

Table 3. Marginal value products of labor for the five selected regions, as estimated and adjusted to 1962

Region and year estimated	Marginal value product	
	For year estimated	Adjusted to 1962
	<i>..... thousands of cruzeiros.....</i>	
Uba, 1961	8.5	13.4
Caratinga, 1962	2.0	2.0
Ituiutaba, 1962	19.0	19.0
Leopoldina, 1962	0.8	0.8
Montes Claros, 1963	72.2	43.4

Table 4. Comparison of differences in the marginal value products of labor in different regions: elasticity coefficient necessary to make the marginal value product of labor in one region equal to that in another region^a

Region for which the test was made	Estimated coefficient	Region against which the test was made				
		Uba	Caratinga	Ituiutaba	Leopoldina	Montes Claros
Uba	0.76	—	0.12**	1.08	0.05**	2.47**
Caratinga	.26	1.7**	—	2.42**	0.11	5.55**
Ituiutaba	.59	0.42	0.06**	—	0.03**	1.35*
Leopoldina	.03	0.47**	0.07	0.66**	—	1.52**
Montes Claros	0.20	0.06**	0.01**	0.09**	0.004**	—

^a One asterisk indicates a statistically significant difference at the 10-percent level between the estimated coefficient and the computed equalizing coefficient in the body of the table. Two asterisks indicate significance at the 5-percent level.

labor among the several regions, holding the levels of the other inputs at their respective geometric means.

An example will help to clarify the nature of the test. The left-hand column of Table 4 presents the coefficients for labor estimated from the data for the several regions.¹⁴ The estimated value of marginal product for labor in Uba was Cr \$13,379 per man-month and that for labor in Caratinga was Cr \$2,020 (Table 3).¹⁵ The estimated coefficients for labor were 0.76 in Uba and 0.26 in Caratinga. In testing for significant differences, one can proceed in two ways. One is to compute the coefficient for Uba which would equate the MVP's between the two regions. Such coefficients are obtained by reading across the table on the line for Uba. In the Uba-Caratinga comparison, the coefficient for labor would have to be reduced to 0.12. Since this is significantly different from the estimated coefficient for Uba (0.76), we conclude that the MVP's are statistically different between the two regions, given the mean quantity of resources used in Uba.

The alternative test involves computing a similar coefficient for Caratinga which would equate the respective MVP's. This coefficient is then tested against the estimated coefficient for Caratinga, and the same statistical test applied. The two tests can give different answers, since in one case the mean quantity of resource in one region is considered and in the other the mean quantity of resource in the other region is considered. For this reason, both tests are summarized in Table 4.

The table consists of two parts—an upper right-hand part and a lower left-hand part—with each part representing the two tests. For example, the test between Uba and Caratinga which uses the estimated coefficient and the mean quantity of labor for Uba appears in the upper right-hand part of the table, and the test which uses the estimated coefficient and the mean quantity of labor for Caratinga appears in the lower left-hand part.

In summary, the tests indicate the existence of underemployed labor in agriculture, since the MVP of labor in some regions is significantly different from that in others. This situation suggests that significant gains may be achieved by reorganizing labor even within the agricultural sector. That is, the results indicate that labor could be reallocated geographically within the agricultural sector with a consequent gain in economic efficiency. It should be noted that significant differences exist among the MVP's even when the analysis is restricted to the three samples that were taken in the same year.

Comparison of the MVP's with Alternate Wage Rates in Agriculture

Since a previous section showed considerable imperfection in the factor market in the sense that labor does not receive its marginal value product,

¹⁴ That is, the coefficients from the production functions presented earlier.

¹⁵ Evaluated at the geometric means of the inputs and outputs.

it seems worthwhile to pose the underemployment question from the standpoint of alternative wage rates as well as from the standpoint of alternative marginal value products. Although not directly useful from a resource efficiency standpoint, the analysis does provide insights into the direction which resource flows would take if labor were to receive the value of its marginal product in its present employment, and it compares this with the current wage rate in alternative employment in agriculture.

Viewed from the standpoint of the individual firm, the analysis shows whether there is a significant difference between the MVP of labor in its production process and alternative wage rates. If the MVP of labor is higher than the wage rates in its own area, the analysis will show the areas from which labor could be attracted if the firm were to pay labor the value of its marginal product in the production process.

The results of such a test are presented in Table 5. The test is made in the same way as the test in the previous section except that the MVP in one region is compared with the current wage rates in each of the other regions.

Table 5. Coefficient required to equalize the marginal value product of labor in one region with the reported agricultural wage in alternative regions^a

Region for which the test was made	Estimated coefficient	Region against which the test was made				
		Uba	Caratinga	Ituiutaba	Leopoldina	Montes Claros
Uba	0.76	—	0.18**	0.34**	0.30**	0.36**
Caratinga	.26	0.54	—	0.77**	0.68*	0.82**
Ituiutaba	.59	0.13**	0.10**	—	0.16**	0.20**
Leopoldina	.03	0.15	0.11	0.21	—	0.22*
Montes Claros	0.20	0.02**	0.01**	0.03**	0.02**	—

^a One asterisk indicates that the computed equalizing coefficient in the table is significantly different from the estimated coefficient at the 10-percent level. Two asterisks indicate significance at the 5-percent level.

Imperfections in the labor market are once again indicated. The MVP's of labor in the selected regions tend to be significantly different from current wage rates in each of the other regions. These differences are in both directions: in some cases the MVP's are lower than the alternative wage rates and in some cases higher. This conclusion holds even when the comparison is restricted to Caratinga, Ituiutaba, and Leopoldina, the three samples taken in the same year.

Intersectoral comparisons

The bulk of the literature on underemployed labor has dealt with agricultural labor in relation to nonfarm employment, with the latter gener-

ally specified as being either in the industrial sector or in the construction of social overhead capital. In this section, an attempt is made to identify underemployed agricultural labor from this standpoint.

Ideally, one would like to have an estimate of the value of marginal product of labor in the various nonfarm employments. Only one such study¹⁶ is known to us, and the results from it are presented in Table 6. It is to be noted that even in the industrial sector, sizable differences exist in the MVP's of labor among the several regions.

Table 6. Marginal value products of man-years of labor employed in Brazilian industry in selected states, 1959

State	1959	Estimated marginal value product adjusted to 1962 prices	
		Man-years	Man-months
	.....<i>thousands of cruzeiros</i>		
Minas Gerais	201.0	615.9	51.3
Rio Grande do Sul	279.2	855.5	71.3
Parana	248.1	760.2	63.3
Santa Catarina	198.9	609.4	50.8
Goiás	170.0	520.9	43.4
Mato Grosso	232.6	712.7	59.4
São Paulo	315.6	967.0	80.6

Source: Delfim Netto [2, p.5]

A test of the MVP for Minas Gerais against those estimated for the agricultural sector shows a significant difference in all regions except Montes Claros (Table 7). In making this test, we assumed a 100-percent difference in the cost of living between the two sectors,¹⁷ but even with this allowance, the difference in MVP's is still very great.

It is difficult to evaluate these findings. On the surface, the results may be subject to serious bias. The median wage rate per month for a broadly defined national industry group was Cr 36,400 in 1959. This is equivalent to an annual wage of Cr \$76,800. On this basis, the industrial sector would appear to be as far out of adjustment as the agricultural sector. Even though a large discrepancy between the MVP of labor in the industrial sector and that in agriculture is consistent with the literature on underemployment, it has not been suggested in the literature that the degree of disequilibrium is this great in the nonfarm sector.

It is possible that the production function for the nonfarm sector is not a valid representation of the production process. For example, installed

¹⁶ This study used *municípios* (counties) as observations and measured labor in man-year equivalents and capital in terms of installed horsepower.

¹⁷ No studies are available to provide a better estimate of differences in the cost of living.

Table 7. Coefficient required to equalize the marginal value product of labor in the selected agricultural regions with the marginal value product of labor estimated for the industrial sector, Minas Gerais, 1962^a

Region	Estimated coefficient	Coefficients needed to equate with MVP's in industry	
		Actual	Adjusted ^b
Uba	0.76	2.92**	1.46**
Caratinga	.26	6.56**	3.27**
Ituiutaba	.59	1.59**	0.79**
Leopoldina	.03	1.80**	0.90**
Montes Claros	0.20	0.28	0.12

^a Two asterisks indicate that the computed equalizing coefficient in the table is significantly different from the estimated coefficient at the 5-percent level.

^b The industrial MVP was reduced by 50 percent to account for the higher cost of living for urban workers.

horsepower has serious limitations as a measure of capital in the industrial sector. To the extent that other forms of capital are highly correlated (positively) with labor,¹⁸ the coefficient for labor could have an upward bias, in turn biasing upward the estimates of the MVP's of labor.

An alternative approach is to consider a wage rate in the industrial sector as an alternative and make the comparison with it.¹⁹ The tests from such a comparison are presented in Table 8.

The wage selected for this comparison was that paid for labor in the textile and food processing industries in Minas Gerais. Both of these industries are frequently located in rural areas, both are sizable industries, and both are able to utilize unskilled labor. In these respects, they appear to provide relatively immediate employment opportunities for the agricultural labor force.

On this criterion, if we assume no difference between sectors in the cost of living, Table 8 indicates that there are significant differences between the wage rate in the industrial sector and the MVP of labor in several of the regions. Uba is the only exception. Three of the remaining four regions have a difference that is significant at the 5-percent level, and one has a difference that is significant at the 10-percent level.

It should be noted, however, that the tests do not indicate underemployment of agricultural labor in relation to industry as a general condi-

¹⁸ Inputs in cross-sectional studies of production functions tend to be highly correlated [4, p. 224].

¹⁹ If the industrial sector were in equilibrium with respect to labor use, the wage rate would provide a measure of the contribution that a unit of labor would make in the nonfarm sector, subject to the condition that it is an average and not a marginal concept. If the industrial sector is not in equilibrium with respect to labor use, then the comparison is subject to even more serious limitations.

Table 8. Coefficient required to equalize the marginal value product of labor in the selected agricultural regions with the average monthly wages reported in the textile and food preparation industries in Minas Gerais, 1962^a

Region	Estimated coefficient	Coefficient needed to equate MVP's with wages in the textile and food preparation industries	
		Actual	Adjusted ^b
Uba	0.76	0.76	0.38**
Caratinga	.26	1.70**	.85**
Ituiutaba	.59	0.41*	.20**
Leopoldina	.03	0.46**	.23*
Montes Claros	0.20	0.06**	0.03**

^a One asterisk indicates that the computed equalizing coefficient in the table is significantly different from the estimated coefficient at the 10-percent level. Two asterisks indicate significance at the 5-percent level.

^b The industrial wage was reduced by 50 percent to account for the higher cost of living associated with urban employment.

tion. Rather, underemployed labor by this criterion exists in only two of the five regions—Caratinga and Leopoldina. The test for Uba indicates that there is no significant difference between the MVP of labor in agriculture and the industrial wage, and the tests for Ituiutaba and Montes Claros indicate that labor could be attracted from the textile and food preparation industries if it were paid its marginal value product in agriculture.

If industrial wages are reduced to account for a lower cost of living in the rural areas, there is a significant difference between the wage rate in the industrial sector and the MVP of labor in all regions. Four of the regions have a difference that is significant at the 5-percent level, with the remaining region having a difference that is significant at the 10-percent level.

But even this sizable reduction in the comparative wage leaves a mixed situation, in which Caratinga and Leopoldina continue to have underemployed labor and the other three regions have coefficients which indicate that they could attract labor from the industrial sector. Uba moves from an apparent equilibrium position to a condition of being able to attract labor from the industrial sectors.

Concluding Comments

Underemployed agricultural labor implies a poorly functioning labor market. The results of the present study suggest that there are several dimensions to this problem, some of which are not generally recognized or given sufficient treatment in the literature. For example, considerable op-

portunity was found for reallocating labor within the agricultural sector.²⁰ This finding suggests that there are employment opportunities within the agricultural sector which can increase the incomes of some groups of the farm population, increase agricultural output, and slow down the mass migration to the cities which is creating serious problems in most Latin American countries.

In addition, we found that in some cases farm labor does not receive the value of its contribution to the production process. Although many groups in Brazil and other Latin American countries have previously suggested this conclusion, orthodox economists trained in "equilibrium economics" tend to ignore it. The data from the present study do not provide a basis for determining whether this condition results from conscious exploitation or merely from the general lack of knowledge in the labor market and among employers. This is a fruitful area for future research.

Two other findings which are not generally recognized in the development literature bear on the functioning of the nonfarm labor market itself and the relation of the nonfarm labor market to the farm labor market. The rather limited data we have presented relative to the first point suggest that the nonfarm labor market functions rather poorly. The rather surprising finding on the second point was that, at least in Brazilian agriculture, some sectors or regions have an MVP for agricultural labor that is greater than the wage rates in the nonfarm sector, and in one case at least is not significantly different from the MVP of labor in the nonfarm sector. These findings are, however, some of the more tenuous of the study.

On the other hand, the crude data on rates of development, shifts in product mixes, and aggregate resource flows suggest that the labor market does work but that it does not accomplish the resource adjustments rapidly enough to meet efficiency criteria at a given point in time. This suggests that market institutions which increase the flow of labor market information and facilitate the transfer of resources could contribute to an enlarged GNP. Whether investments in such institutions would be appropriate would require a cost-benefit evaluation of such institutions—another fruitful line of research.

Although our sample of *municipios* is small, there appears to be little or no correlation between the degree of industrial-urban development and the performance of the labor market. One of the regions in which the null hypothesis of zero marginal productivity was not rejected (Leopoldina) is located close to well-developed urban-industrial complexes and is fairly well integrated into these markets through the product market. Other areas that are much more isolated do not appear to be as far out of adjustment. Identification of key factors affecting the performance of the

²⁰ For a similar finding, see Paglin [13, p. 816].

labor market is an important area of research for the purpose of developing policies that will facilitate a more rapid adjustment to economic change.

The lack of correlation between the degree of industrial-urban development and the performance of the labor market suggests that some of the more important barriers to labor mobility may not be distance and lack of knowledge but rather a lack of skills as a result of inadequate schooling and training programs. Policies directed toward providing better education may be more important in increasing the rate of growth in Brazil than attempts to create more job opportunities through forced-draft industrialization, especially if the latter encourages capital-intensive high-skill-demanding industrialization.

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Determinants and Development Implications of Foodgrains Prices in India, 1949-1964*

JOHN W. MELLOR AND ASHOK K. DAR

A price index for foodgrains in India for the period 1949-1964 is estimated as a function of a set of real demand and supply variables and the money supply. More than 80 percent of the variation in the foodgrain price index is associated with variation in these independent variables. The upward trend in foodgrains prices is associated primarily with expansion of the money supply. There is little evidence of government foodgrain price policy having affected the trend of relative agricultural prices. The coefficient on the lagged supply-demand variable suggests that year-to-year changes in farmers' storage stocks are an important determinant of foodgrains prices in any one year. The implications of these findings to the relation between agricultural and industrial growth, monetary and fiscal policy, and agricultural price and buffer-stock policy are discussed.

CONTEMPORARY growth theory treats the relative price of foodgrains as one of the most important determinants of savings and investment rates in both the industrial and the agricultural sectors of low-income countries. Rising foodgrains prices directly depress savings and investment rates in the industrial sector by forcing up money wages with consequent depression of profits [3, 8, 10, 12]. Rising foodgrains prices also increase urban political unrest, directly and indirectly force government expenditures for increased money wages, and decrease the availability of government funds for fostering industrial growth. In contrast, in the agricultural sector, rising foodgrains prices increase the profitability of farm investment and the income pool from which agricultural savings may be drawn [11]. Despite this key role, little empirical study has been made of either the relative movements of foodgrains prices over the course of time or of the determinants of those movements.¹ There remains considerable controversy, but little empirical evidence, concerning the influence on foodgrains prices of production changes as compared to the influence of speculative activities in private trade, farmers' storage activities, and government policies [1, 9, 19].

This article examines the movement of foodgrains prices in India during the period from 1949-50 to 1963-64. India provides relatively good sta-

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¹ As an exception, see Lewis and Hussain [7].

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tistical data, is in an early stage of economic development with a high proportion of national income and employment in the agricultural sector, has an economy of sufficient size to make domestic economic policy relatively important as compared to externally generated policies, and has over the past two decades followed a number of different policies on foodgrains prices.

The period of 1949-50 to 1963-64 is one for which relevant statistical data are available, with relatively constant definitions throughout. Perhaps most important for statistical measurement, this period contains series of years with differing fluctuations in most of the relevant variables, a situation which reduces errors arising from correlation of the variables with each other and with time.²

The Estimated Equation for Foodgrains Prices

The estimated equation thought to be best specified for the purposes of this study is (with standard errors in parentheses)

$$P_t = 41.48 + 0.56(D - S)_{t-1} + 2.25(D - S)_{t-2} + 2.06M_t \quad (R^2 = 0.83)$$

(0.08) (0.80) (0.35)

where

P_t is the index of foodgrains prices (1952-53=100) at wholesale markets in the first week of April of year t ;

D is the estimated aggregate real demand for foodgrains for the year commencing July 1, in millions of long tons;

S is the estimated aggregate supply of foodgrains for the year commencing July 1, in millions of long tons;

$t-1$ is the year commencing July 1 preceding April 1 of the year t ;

$t-2$ is the year commencing July 1 of the year preceding $t-1$; and

M_t is the total money supply with the public, as defined by the Reserve Bank of India, in the first week of April of year t , in billions of rupees.

The dependent variable, price of foodgrains (P_t), is defined as the index of foodgrains prices in the first week of April, because by April the preceding rainy-season harvest is several months past and the dry-season harvest is sufficiently well along so that traders and merchants have a good idea of the current year's production. No basis for predicting the weather for the next rainy-season crop exists by April, although such basis begins to develop in May as the monsoon commences in parts of India. Thus, in April there is no knowledge of the size of the next season's crop but good knowledge of the size of the preceding year's crops. Prices at

² Before 1949-50, disruptions of partition, war, and depression reduce the relevance of analysis to contemporary problems; after 1963-64, various price regulations and evasion of those regulations reduce the validity of published data.

almost any other time of the year represent a constantly shifting blend of changing expectations concerning the level of production.³

The expression $D-S$ is defined for each year as the gap between aggregate real demand and supply based on the change in demand and supply from the base year, 1949-50. It reflects changes in domestic production, imports, and government storage stocks on the supply side, and population and real income growth on the demand side.

Supply (S) is expressed for each year in long tons, as the sum of the three supply sources for which data are available—domestic production, imports, and changes in government-held stocks (Table 1). There are no data for changes in privately held stocks, so they are not included in the measurement. As will become apparent later, the lagged variable representing the gap between demand and supply reflects changes in private stocks.

Aggregate demand (D) is taken as equal to supply in the base year 1949-50. Aggregate demand in subsequent years is calculated by using D in 1949-50 as a base and adjusting for population change and change in per capita income, which are considered to be the major factors that shift demand (Table 1). In calculation of aggregate demand, the income elasticity of demand for foodgrains is assumed to be 0.5; this figure is based on analysis of the Indian National Sample Survey and other sources [14, 16]. Given this method of calculation, the gap between demand and supply ($D-S$) is by definition zero in the base year 1949-50. That year is generally regarded as a year of normal weather.⁴ The observations used and the calculated values of S , D , $D-S$, and M are shown in Table 1.

Inclusion of the money-supply variable (M) allows study of its separate effect. In an alternate equation, the money-supply variable was dropped and money income was substituted for real income in the calculation of demand. In that equation the R^2 was 0.45, as compared to 0.83 in the preferred equation. Likewise, in the alternate equation the appearance of the same strong money influence in both the $D-S$ variable for $t-1$ and for $t-2$ caused the correlation coefficient between the two variables to be 0.55, whereas in the preferred equation it was only 0.20.

Comparison of Estimated and Reported Prices

When we use the above equation, for only 4 of the 13 years does the estimated price deviate more than 5 percent from the reported price (Fig.

³ The choice of April price is consistent with Working's hypothesis as initially tested under United States conditions and further tested by Lele under the conditions of sorghum pricing in India [6, 20]. In contrast to the R^2 of 0.83 with the above equation, when foodgrains prices (P_t) were redefined as the average price for the crop-year July 1 to July 1, instead of as April prices, the R^2 dropped to 0.42.

⁴ In fact, the weather in 1949-50 was probably somewhat more favorable than normal and hence the "gap" is shown as zero in a somewhat better than average year for agricultural production.

Table 1. Estimates of aggregate demand and supply factors for foodgrains, India, 1949-50 to 1963-64

(1) Years	(2) Population millions	(3) Per capita income ^a Rs.	(4) Aggregate demand ^b (D)	(5) Produc- tion ^c	(6) Imports	(7) Change in govern- ment stocks	(8) Aggregate supply ^d (S)	(9) Gap between demand and supply ^e (D-S)	(10) Index of cereal prices ^f	(11) Index of pulse prices ^f	(12) Index of food- grains prices ^g	(13) Money supply ^d
					million long tons				1952-53 = 100			billion Rs.
1949-50	357.5	251	53.7	50.4	3.7	+0.4	53.7	0.0	91	79	89	—
1950-51	363.4	248	54.2	45.7	4.7	+0.5	49.9	+4.3	103	102	103	18
1951-52	369.6	250	55.4	46.1	3.9	+0.6	49.4	+6.0	98	98	95	18
1952-53	376.1	256	55.9	51.3	2.0	+0.5	53.8	+2.1	96	93	95	18
1953-54	382.9	256	59.2	60.0	0.8	+0.2	60.6	-1.4	89	74	87	18
1954-55	390.2	268	60.6	58.8	0.6	+0.7	60.1	-0.5	89	74	85	19
1955-56	397.8	268	61.7	57.6	1.4	-0.6	59.6	+2.1	89	74	87	22
1956-57	405.8	276	63.9	60.2	3.6	+0.8	63.0	-0.9	101	74	87	23
1957-58	414.3	267	64.2	55.4	3.2	+0.2	58.8	+5.4	107	82	95	24
1958-59	423.7	280	67.2	66.4	3.8	+0.4	66.8	-2.6	99	89	95	25
1959-60	432.0	279	68.6	66.1	5.1	+1.4	69.8	-1.2	104	89	102	27
1960-61	442.0	293	71.8	69.7	3.4	+0.1	73.2	-1.4	99	88	97	29
1961-62	450.5	294	73.3	69.0	3.6	+0.3	72.3	+1.0	103	94	102	30
1962-63	459.1	293	74.5	67.8	4.5	0.0	72.3	+2.2	107	103	106	33
1963-64	468.1	300	76.9	68.4	6.2	0.0	74.6	+2.3	124	134	126	37

^a Measured in constant prices of 1948-49.^b Estimated as follows:Aggregate real demand in period $t = L_t \{ Q[1 + (\Delta Y/Y)^b] \}$,

where

 L_t is population in period t . Q is per capita consumption in 1949-50. Y is per capita real income in 1949-50. ΔY is increase in per capita real income by period t , and b is income elasticity of demand for foodgrains.^c For human consumption only, estimated at 87.5 percent of production, 12.5 percent is allowed for feed, seed, and waste.^d April data.^e Sum of columns 5, 6, and 7.^f Column 4 minus column 8.^g Estimated as the weighted average of cereals and pulses.

Sources: Government of India [4] and Reserve Bank of India [18].

1A). The substantial deviation in 1954-55 appears to result from the fact that in two consecutive years unusually good crops had a cumulative effect in depressing prices. This effect is understated by the form of equation used. Speculative influences may have reinforced this effect. In 1958-59 and 1959-60, it is probable that introduction of state trading in foodgrains caused abnormal marketing and storage patterns [5].

With the money supply held constant, there is either no trend or perhaps a slight downward trend in the estimated price of foodgrains (Fig. 1B). Conversely, one can say that the upward trend in the actual prices of foodgrains in this period is due, not to an enlarging gap between supply and demand, but to expansion of the money supply. Particularly in the 1960's, money supply expanded substantially in response to problems of both defense and development. A nonparametric test demonstrated that foodgrains prices probably declined slightly relative to all other prices during this period.⁵ In contrast, according to the same nonparametric test, all agricultural prices, including industrial raw material crops, vegetables, and livestock products, in addition to foodgrains, held an essentially constant relationship to nonagricultural prices during this same period.⁶ Thus, a relative price increase for nonfoodgrains agricultural commodities somewhat more than balanced the small relative decline in foodgrains prices. As can be seen from Table 1, showing imports, and Figure 1D, showing estimated prices without imports, the role of imports in the trend of foodgrains prices has been essentially neutral except perhaps for the last two years of the series.

The data show that, during the period studied, relative growth rates of the agricultural and nonagricultural sectors have been consistent with a stable relationship of agricultural and nonagricultural prices. This is, of course, not to say that this consistency has been either planned or optimal or that it has been maintained at all times within that period. Indeed, from 1955 to 1959 and from 1960 to 1964, foodgrains prices increased as a result of more rapid growth in demand than in supply (Fig. 1B). Conversely, from 1952 to 1959 and from 1959 to 1960, foodgrains prices declined as supply grew more rapidly than demand. These contrasting movements are consistent with the hypothesis that unbalanced growth between agriculture and nonagriculture will be self correcting [10, pp. 73-79]. In years in which demand for foodgrains was increasing more rapidly than supply, the consequent rise in agricultural prices caused increased money wages; it also lowered incentive to invest in the nonagricultural sector and reduced funds available for such investment, thereby slowing expan-

⁵ Using the method of ranking each observation, the computed total score was +8 and the rank correlation coefficient was 0.1. For a fuller discussion see Mellor and Dar [13].

⁶ The computed total score was -2 and the rank correlation coefficient was -0.026.

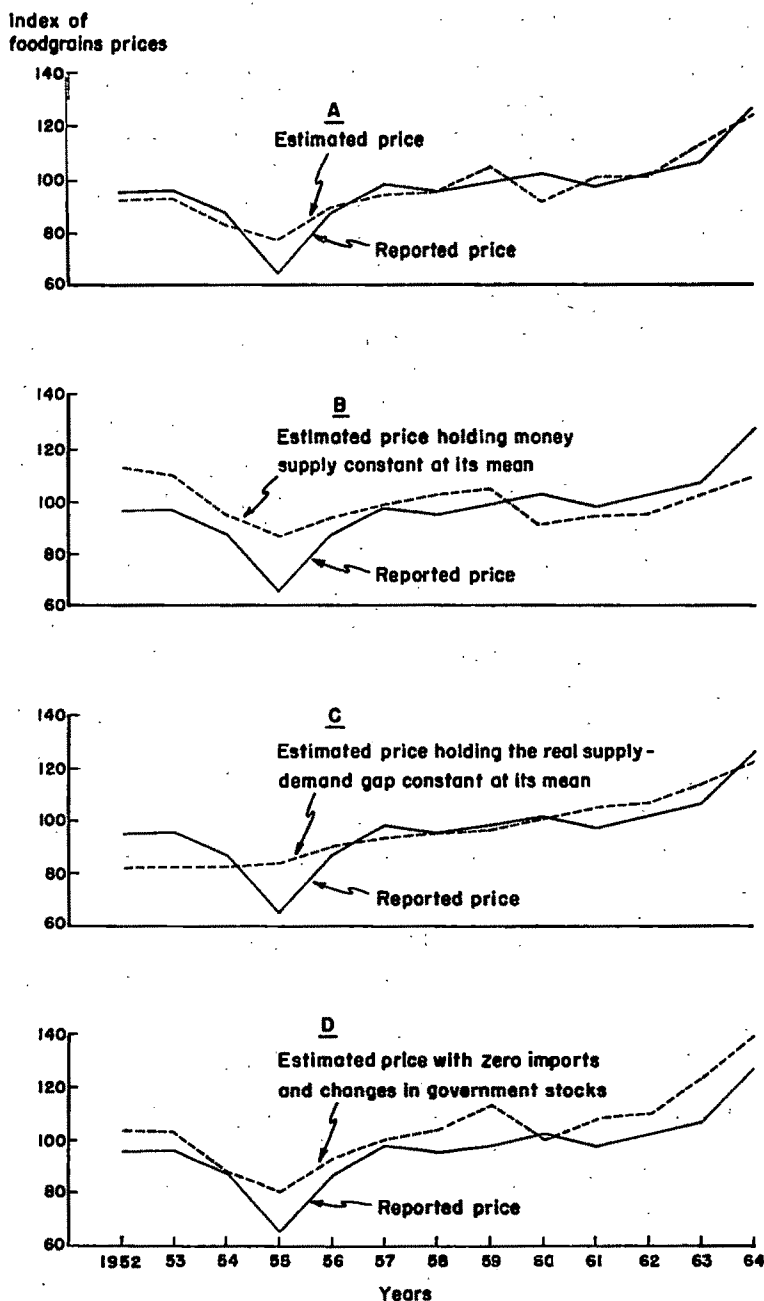


Figure 1. Comparison of reported with estimated April foodgrains prices, India, 1951-1964

Source: Reported prices from Table 1; estimated price in 1A computed from the price equation in the text; estimated price in 1B, 1C, and 1D computed from the same equation, but with the specified variables held constant as stated.

sion of the nonagricultural sector. Conversely, when agricultural production grew more rapidly than demand, the consequent decline in agricultural prices provided incentive and funds for increased investment in the nonagricultural sector. More rapid growth in agricultural production would presumably have allowed faster average growth rates in the nonagricultural sector, with consequent greater expansion in the demand for agricultural commodities. It is noteworthy that, in this argument, relative movements in agricultural prices are the indicators and not the cause of success or failure in the agricultural sector.

The tendency for sharp fluctuations in agricultural production and for runs of successively declining and rising production calls for care in making judgments about the success of agricultural development policies. For the periods of relatively low production, such as 1955 to 1959, 1960 to 1963, and 1965 to 1967, unjustified conclusions about the deleterious effects of imports and domestic price policy may be drawn. For the periods of high production, such as 1953 to 1955, 1959-60, and 1964-65, even more unjustified conclusions may be drawn as to the effectiveness of production policy. The two situations together divert attention from policies encouraging production-increasing technological change and towards policies of price regulation and restriction of trade and food aid.⁷

The close fit of the estimated prices to reported prices supports the assumption that, for the period 1949-1964, the reported prices closely reflect actual market conditions. Presumably there would be a much larger random error in the equation if the reported prices were randomly reported or were fixed prices of wide and varying disparity from black market prices.

Farmer Stocks of Foodgrains

Government storage stocks are known and enter the price equation explicitly. No data are available for private stocks. Although it is generally assumed that traders do not carry significant quantities of grains from one year to another, there is disagreement about whether farmers do so. On the one hand, it is argued that farmers are too poor and too indebted to store grain from one year to another, and that in any case it is normally not profitable to do so. On the other hand, it is argued that stocks do provide protection against future bad crop years, that the farmers who produce the bulk of marketed supply have ample financial power to hold stocks, and that such storage may, at least in some years, be highly profitable.

In the price equation presented here, the substantial coefficient of the $D-S$ variable for the lagged year, $t-2$, suggests that year-to-year change in farmer-held stocks is of considerable importance in determining annual

⁷ There has been a good deal of controversy on these matters [1, 9, 19].

foodgrains prices. Apparently, in a year of very large crops there is substantial storage and carry-over to the next year; thus, prices are depressed less in the year of a big crop and more in the year following. Conversely, in a year of very small crop normal carry-over stocks are drawn down, reducing the immediate effect of the poor crop on prices. This situation provides a stabilizing effect on prices, unless there are successive years of crop failure or bumper production, in which case prices react sharply, as they did in 1954-55 and 1966-67.

The coefficient of the $D-S$ variable for $t-2$ suggests occasional annual changes in on-farm carry-over stocks of as much as four or five million tons (Table 2). A large proportion of total foodgrains production is stored on the farms where it is produced and consumed. Thus, the modest percentage increment to normal post-harvest storage stocks which these figures suggest is a much larger proportion of total marketings. This element of leverage is important in explaining storage and price behavior.

Table 2. Estimates of net changes in private foodgrains stocks, India, 1952 to 1964

Years	Estimated with $(D-S)_{t-2}$ held constant ^a	Estimated on the assumption that equation error is due to changes in private stocks ^b	Sum of the two estimates
	<i>millions of long tons</i>		
1952	+3.3	+1.3	+4.6
1953	+4.8	+1.3	+6.1
1954	+1.2	+1.8	+3.0
1955	-2.8	-5.3	-8.1
1956	-1.0	+0.9	-0.1
1957	+0.6	+1.3	+1.9
1958	-1.0	—	-1.0
1959	+4.1	-2.7	+1.4
1960	-3.9	+4.9	+1.0
1961	-1.6	-1.3	-2.9
1962	-2.6	+0.4	-2.2
1963	-0.4	-3.1	-3.5
1964	+0.8	+0.9	+1.7

^a Calculated by estimating prices from the price equation with the $(D-S)_{t-2}$ term held constant at its mean. The difference between the derived estimates and the original estimates of yearly prices is assumed to be due to changes in stocks in the $(D-S)_{t-2}$ term. The change in private stocks needed to give this change in price is estimated by subtracting the equation with $(D-S)_{t-2}$ constant at its mean from the equation as originally presented, and solving for the value $(D-S)_{t-2}$.

^b Calculated as above, but assuming that the difference between the estimated and reported prices is entirely due to misestimation of the $(D-S)_{t-2}$ term.

In the equation presented here, the coefficient for $D-S$ in $t-2$ suggests that increase or decrease in private storage is determined entirely by the previous year's crop.⁸ However, the much larger standard error for $t-2$

⁸ In an alternate equation which included a $D-S$ variable for $t-3$, the regression coefficient for this variable was 0.01, with a standard error of 0.8.

than for $t-1$ suggests that farmers vary their storage decisions less systematically according to the size of crop than this equation implies. Indeed, it seems likely that a substantial portion of the error in the price equation is due to faulty specification of this variable. Table 2 presents the changes in storage stocks implied in the assumption that the equation error is due entirely to changes in private stocks.

If data were available for a longer period of years, a more complex and accurate description of farmers' storage activities might be provided. However, the variation in carry-over stocks may have an important random element. Insofar as this is true, price behavior in any one year would be exceedingly difficult to predict. The policy implication is that one must either (1) take measures which provide substantial public control of markets through holdings of public stocks, or (2) undertake a degree of measurement and regulation of private stocks that is probably impossible even with respect to the traders, let alone the much larger number of farmers, or (3) be prepared for some price instability that is based on naïve speculation in addition to basic consumption and production factors. In the longer run, a program of farmer education and collection and dissemination of accurate price and storage information would be helpful.

The rise in farm incomes and the even greater expansion in credit available to farmers which have accompanied the social and economic changes of the past two decades have increased the ability of farmers to hold stocks. If farmers are naïve speculators, less informed concerning broad supply and demand changes than the traditional trading community, an increase in their holding capacity may lead to less stable markets and price relationships. In other words one of the concomitants of agricultural development may be forces leading to greater instability of market prices. These forces may increase the value of effective price stabilization and market information schemes in the context of agricultural development.

In the study of farmers' storage activity, it is important to remember that a substantial proportion of aggregate foodgrains production and, to an even greater extent, of the total marketable surplus is produced on a minority of farms [15]. Thus, it is not inconsistent to find the majority of farmers with completely depleted stocks prior to a new harvest, while at the same time an amount equal to, say, 5 percent of total production and of course a much larger percentage of total marketings is carried over to another year on the farms of the 10 to 20 percent of the farmers with the larger holdings.

It is interesting to note that our foodgrains price results are in sharp contrast with most lagged models, which show progressively smaller coefficients for each successively more distant year. In a similar equation for industrial raw material crops, including such crops as oilseeds and cotton,

a more normal pattern was observed, each successively earlier year, $t-1$, $t-2$, $t-n$, having a progressively smaller coefficient [2]. In the case of industrial raw material crops, farmers apparently sell essentially the entire crop in the year produced. It is reasonable to assume that the results for foodgrains are typical of a crop involving storage for home use, which represents a high proportion of total production, with the consequent leverage effect described above.

The Effect of Money Supply on Foodgrains Prices

The upward trend in foodgrains prices is largely accounted for by the trend in the money-supply variable (Figs. 1B and 1C). The coefficient for the money-supply variable is difficult to interpret—in part, because the variable is naïvely defined. The most interesting interpretation of the coefficient suggests that the increased money income associated with expansion of the money supply has an implicit income elasticity of demand substantially lower than the 0.5 assumed for calculating the demand effects of real income changes.⁹ The pattern of government deficit spending and of private expenditure financed by expanded bank deposits may have significantly shifted income distribution towards higher income groups with lower income elasticities of demand. Such an assumption is consistent with the impression that Indian economic expansion has so far emphasized high investment and low employment activities.

The more investment policy is oriented towards expanded employment of unskilled laborers with low incomes, the more income will be distributed towards persons with high income elasticities of demand for food and the more pressure there will be on food supplies. The converse applies to investment policy oriented towards imported capital goods and the skills of higher-income persons. Looked at from a different perspective, rapid increase in agricultural production and the ready availability of imported food on concessional terms allows an investment policy which is heavily employment-oriented. PL 480 supplies, coupled with a strong employment-oriented investment policy, need have little effect on food prices, because the supply effect of PL 480 can be largely balanced by the demand effect of increased employment of persons with low income and

⁹ Calculated at the mean, the coefficient on the money-supply variable implies that a 1-percent increase in the money supply increases the price index of foodgrains by 0.53 percent. Assuming that money income expands proportionately with money supply, then a 1-percent expansion of money income will increase the price index by 0.53. As will be seen later, interpretation of the coefficients for the $D-S$ variables provides a price flexibility coefficient of -1.83 . Taking demand and supply changes of the same size as interchangeable and the assumed income elasticity of demand as 0.5, a 1-percent increase in real income will increase the price index by 0.92 percent. The coefficient 0.53 is nearly 60 percent of 0.92, consistent with an income elasticity of demand of 0.3 for foodgrains based upon money income as compared to 0.5 assumed in the real-income calculations.

hence high income elasticities of demand for food. The balance of these forces can be determined by public policy. More generally we may say that because of wide differences among income classes in income elasticities of demand for food, changes in income distribution can be as important as changes in average income in determining growth in the demand for food and the resulting pressure on food prices.

The money-supply variable may serve as a proxy for various trend factors. Perhaps, most plausibly, there has been a downward trend in the income elasticity of demand for foodgrains rather than the constant level assumed in the demand estimates. In an empirical sense, if such a decline were related to the upward trend in availability of consumer goods, it would probably correlate with the expansion in the money supply. If a downward trend in income elasticity were associated with rising real incomes, then the correlation with the money supply would not be as close. It is also possible that there is an upward bias in the real-income estimates used, which is corrected by a trend factor associated with money income.

The significant conclusion from this analysis of the money-supply variable is that there are one or more important factors which influence prices of foodgrains in an important manner and which are as yet little understood. These may include the effect of changes in income distribution, particularly as affected by development policy itself, secular changes in income elasticities, or other factors. This is an interesting and potentially important area for further inquiry.

Foodgrains Imports

Subtraction of foodgrains imports from the calculation of supply in the price equation provides the estimated price shown in Figure 1D. Without imports, foodgrains prices in India during the period studied would have been about 10 percent higher on the average, with a range from about 3 percent to 14 percent higher. Although there is not clear evidence of an upward trend in imports during the period studied, there has been some tendency for fluctuations in imports to dampen fluctuations in domestic prices.

An alternative formulation of the price equation which excluded imports from the measure of supply provided an equally good fit and similar coefficients to those in the equation presented. Comparison of the two equations confirms a lack of trend effect from imports.

Estimation of Price Elasticity of Demand

A price elasticity of demand can be calculated from the price equation¹⁰ by first deriving a price flexibility coefficient which combines the coeffi-

¹⁰ The method used is that described by Nerlove [17].

cients of $D-S$ for $t-1$ and $t-2$. The coefficient of 2.81 is converted to a price flexibility coefficient¹¹ by taking the average demand and average price index and deriving the price flexibility coefficient of -1.83 . This figure is interesting in itself, suggesting that a 1-percent change in demand will change the price index by 1.8 percent. An estimate of the price elasticity of demand of -0.55 is derived by calculating the inverse of the price flexibility coefficient. This figure is consistent, as suggested by the Slutsky-Schultz relation [12, pp. 28-29], with the assumed value of 0.5 for the income elasticity of demand, and an assumption of a very low substitution elasticity. These estimates appear to be reasonable in the context of the Indian economy and lend support to the credibility of the specification of the price equation used and to the meaningfulness of the coefficients derived in this study.

Conclusions

For the period from 1949-50 to 1963-64, it is possible to explain over 80 percent of the variation in foodgrains prices in India with a measure of variations in the gap between supply and demand and in the money supply. The upward trend in foodgrains prices during the period is largely associated with expansion of the money supply, whereas the fluctuations from year to year are largely associated with weather-induced fluctuations in production. Changes in foodgrains imports account for little of the trend movement and serve to dampen slightly the year-to-year fluctuations around the trend.

Expansion of the money supply, through its effect on money income, has apparently increased the demand for foodgrains less than would an equivalent increase in real income, suggesting that expansion of the money supply in India has been associated with redistribution of income towards higher-income consumers. Further inquiry is needed into the effect of changing income distribution on the demand for foodgrains and the resultant interaction between employment and income policy on the one hand and food supply programs and food prices on the other.

Farmers apparently increase storage stocks substantially in years of large crops and draw them down in years of small crops. This practice dampens price fluctuations unless there are two or more successive years of large or small crop, in which case the price changes are very large. The relatively large standard error for the lagged demand-supply variable suggests that farmers' storage decisions are not highly predictable and provide a major source of error in estimating future price levels. Since farmers' storage decisions are so important to price determination, it would be useful to study this matter more carefully.

¹¹ The sign change arises from the "gap" variables being expressed as $D-S$ rather than $S-D$.

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Capital Formation and Growth in the Israeli Cooperative Farm*

EZRA SADAN

The Israeli cooperative farm is characterized by a high rate of expansion; the annual rate of growth of the cooperatives' gross product is 11.5 percent. The analysis of the growth pattern of this farm enterprise from 1936 to 1960 suggests that 2 percent of the annual rate of growth of the gross product can be attributed to capital, 1.5 percent to land and labor, 5 percent to the extended utilization of raw materials, and a residual of 3 percent to "technical progress." A closer examination reveals that a considerable portion of the last is associated with capital formation, probably as a result of technological improvements carried through the flow of gross investments. A smaller portion of the unexplained growth can be attributed to improvements in the "managerial capacity" of the firms under study.

ISRAEL'S agriculture is rated among the fastest growing in the world [9, p. 54]. The cooperative farm, which is the core of Israel's agriculture, is characterized by a high rate of expansion associated with an extensive flow of gross investments and a keen effort to adopt the latest innovations in the field of agro-technology. This article discusses the factors determining the pace of growth of the Israeli cooperative farm, with special emphasis on the role played by capital formation.

A model of the growth of a farm is drawn in the first section. Technical progress and capital formation in this model are considered, first as two separate developments and then with technical progress assumed to be partially embodied in capital. The second section contains the quantitative analysis of these alternative formulations.

The Potential Pattern of Growth

Exogenous limitations on the growth of the farm firm

The model used here to appraise the real contribution of changes in input endowments in general, and capital formation in particular, to the growth in the production of the cooperative farm is derived from the traditional theory of the firm. Adopting an approach simpler than that developed by Edith Penrose [7], the model presented does not penetrate the internal process of development of the firm. It is assumed that external restraints, impeding the expansion of the firm in using the services of production agents, constitute a limitation to the growth of the farm firm.

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External capital rationing is one restraining factor of this type. Thus, for example, the model of growth of the farm firm recently developed by Halter [2] includes an exogenous variable limiting the extent of borrowing. Lending to the firm is assumed by Halter to be proportional to the operators' equity. This assumption is justifiable, of course, in terms of the common practice [1].

The Israeli cooperatives, not unlike family farmers elsewhere, were subject to rationing procedures which reflected, in this case, the policy of the authorities controlling the farm-credit agencies. Yet, unlike the family farms, the established cooperatives were relatively large enterprises organized in national associations involving strong, though somewhat informal, mutual liability arrangements. Thus, the Israeli cooperatives could raise funds in the open market, the major instruments of which were promissory notes.¹

The rate of interest, which was the real limitation in this case, could be looked upon as a weighted average of the rates charged on new loans in the various markets. Let b stand for the maximum proportion of a new investment that the credit agencies will lend, and r_b and r_f stand for the rates of interest charged by the agencies and the discount rate on promissory notes, respectively. The rate of interest referred to by the firm considering the prospects of new investments is expressed in the following equation:

$$(1) \quad r = br_b + (1 - b)r_f.$$

In a sense, the farm firm considered here was free of financial limitations resulting from an explicit barrier or from the operators' fear of take-over. Ignoring questions about the process of growth, we may ask, How large could this farm firm grow? In a framework of family farming, the limit might be set by the family labor supply or, alternatively, by the available managerial capacity.

Similarly, the cooperative farms of this study could be looked upon as enlarged family farms in which the supply of labor was limited by the size of the cooperative membership—the enlarged household. Adherence to policies which resulted in a limitation on the employment of nonmembers' labor in the *kibbutz* farm might have been necessary in order to maintain the structure of cooperative living or it might have reflected the personal and social values held by the *kibbutz* membership. Either way, the growth of the cooperative household conditioned the growth of patterns of the cooperative farm firm.

Accessible arable land in Israel is controlled by a government agency

¹ "Open market" borrowing accounted for 38 percent of the net increments of credit extended, in 1960, to the group of established cooperatives studied here. The respective percentages in earlier periods were 12 percent in 1955, 4 percent in 1950 and 1945, and 24 percent in 1940. The corresponding ratios of the real equity, excluding capital gains, due to inflation (that is, capital loss to the lenders) to the real value of the cooperatives' total assets were 18 percent in 1960, 24 percent in 1955, 26 percent in 1950, 31 percent in 1945, and 21 percent in 1940.

which allots land parcels to *kibbutz* and non-*kibbutz* enterprises on a long-term basis. The rigid land tenure system, which impedes, if it does not actually eliminate, transfer of land rights as well as water rights, affects potential farm size.

The pace of growth

Let us assume that the firm in question, operating in a world of fixed prices, has a Cobb-Douglas production function,

$$(2) \quad G_t = \beta_0 e^{\gamma t} K_t^{\beta_1} N_t^{\beta_2} L_t^{\beta_3} C_t^{\beta_4} \quad \left(\sum_{k=1}^4 \beta_k = 1 \right),$$

where

G_t is the gross product measured in value terms,

γ is the coefficient of the state of technology which signifies the annual rate of change in total factor productivity,

K_t is the capital endowment in year t ,

N_t is the labor endowment in year t ,

L_t is the land endowment in year t , and

C_t is the current expenditure on raw materials.

If we assume that the firm maintains a profit-maximizing policy with respect to C_t , equation (2) may be replaced by a more familiar expression. Equation (3) relates the net product (that is, gross value added, Q_t , imputed as the difference between G_t and C_t) to the capital, labor, and land inputs:

$$(3) \quad Q_t = \alpha_0 e^{\mu t} K_t^{\alpha_1} N_t^{\alpha_2} L_t^{\alpha_3},$$

where

$$\alpha_k = \frac{\beta_k}{1 - \beta_4},$$

and thus

$$\sum_{k=1}^3 \alpha_k = 1, \quad \mu = \frac{\gamma}{1 - \beta_4},$$

and

$$\alpha_0 \approx (1 - \beta_4)(\beta_0 \beta_4) \frac{1}{1 - \beta_4}.$$

The capital endowment is represented by the sum of depreciated gross investments made in the past. Following a long- as well as a short-term policy of profit maximization, the firm is apt to maintain

$$(4) \quad \frac{\partial Q_t}{\partial I_t} = \alpha_1 \frac{Q_t}{K_t} = R,$$

where $\partial Q_t / \partial I_t$ is the marginal productivity of investment and R is the sum of the rate of interest r and the rate of depreciation d .

This assertion can be interpreted as follows. The discrete approximation of K_t is expressed in the equation

$$(5) \quad K_t = \sum_{v=0}^t I_v (1+d)^{(t-v)}.$$

The firm is willing to maintain

$$(6) \quad \sum_{t=v+1}^H \frac{\partial Q_t}{\partial I_v} (1+r)^{(v-t)} = 1;$$

but

$$\frac{\partial Q_t}{\partial I_v} = \frac{\partial Q_t}{\partial I_t} (1+d)^{(v-t)} \quad \text{and} \quad H \rightarrow \infty.$$

Hence, on the assumption that $I_t > 0$ for $t = v+2, v+3, \dots$, the rule implied is the one indicated by equation (4).

Differentiating (2) with respect to time and dividing both sides of the equation by G , we arrive at the well-known theorem,

$$(7) \quad \frac{\dot{G}}{G} = \beta_1 \frac{\dot{K}}{K} + \beta_2 \frac{\dot{N}}{N} + \beta_3 \frac{\dot{L}}{L} + \beta_4 \frac{\dot{C}}{4C} + \gamma = \frac{\dot{Q}}{Q}$$

where

$$\dot{G} = \frac{\partial G}{\partial t}, \quad \text{etc.}$$

Given R , the anticipated rate of growth of both the capital endowment and the product is

$$(8) \quad \frac{\dot{G}}{G} = \frac{\dot{K}}{K} = \frac{1}{1 - \beta_1 - \beta_4} \left[\beta_2 \frac{\dot{N}}{N} + \beta_3 \frac{\dot{L}}{L} + \gamma \right] = \frac{\dot{Q}}{Q}.$$

The pattern outlined above is easily traceable to models, generally including the underlying assumption of an autonomous population growth, constructed for large sections or for the entire national economy [10].

Embodied technical progress

Technical progress has been treated so far as a gift, falling like manna from heaven. Particularly, progress has been considered separable from capital formation. With some elements of the "embodied technology"

approach of Solow [11, 12] and Phelps [8] incorporated into the analysis, it is now assumed that part of the technical progress is carried by the flow of capital goods. This approach implies that, in integrating past investments in order to determine the capital variable admissible in the aggregate production function analysis, technological superiority of more recent vintages of productive assets should be taken into consideration.

Define I_v^* as the "equivalent investment," which takes into account both quantitative and qualitative aspects, made in year v as follows:

$$(9) \quad I_v^* = I_v e^{\psi v},$$

or, in discrete approximation,

$$(10) \quad I_v^* = I_v (1 + \psi)^v,$$

where I_v is the recorded investment figure and ψ is a rate of embodied technical progress. Define the "equivalent stock," J_t , as follows:

$$(11) \quad J_t = \sum_{v=0}^t I_v^* = \sum_{v=0}^t I_v (1 + \psi)^v.$$

Inserting J_t into (2) and (3) instead of K_t , we arrive at the new "rule" implied by a policy of profit maximization:

$$(12) \quad \frac{\partial Q_t}{\partial I_t} = \alpha_1 \frac{Q_t}{J_t} (1 + \psi)^t = \bar{R},$$

that is,

$$\alpha \frac{Q_t}{J_t / (1 + \psi)^t} = \bar{R},$$

where the denominator is the equivalent stock measured in units of productive capacity of a current unit of investment rather than of a base period.

Not unlike "rule" (4) the new "rule" (12) is pertinent to the firm's willingness to maintain equality (6). Since now

$$\frac{\partial Q_t}{\partial I_v} = \frac{\partial Q_t}{\partial I_t} [(1 + d)(1 + \psi)]^{v-t},$$

\bar{R} is defined as the sum of the rate of interest, the rate of depreciation, and the rate of embodied technical progress.

Assuming for the sake of simplicity that both \dot{N}/N and \dot{L}/L are nil, we find that the anticipated rates of growth are now

$$(13) \quad \frac{\dot{J}}{J} = \frac{1}{1 - \alpha_1} [\mu^* + \psi],$$

and

$$(14) \quad \frac{\dot{Q}}{Q} = \frac{1}{1 - \alpha_1} [\mu^* + \alpha_1 \psi] = \frac{1}{1 - \beta_1 - \beta_4} [\gamma^* + \beta_1 \psi] = \frac{\dot{G}}{G}.$$

In the absence of capital formation—that is, when \dot{J}/J is nil—the rates are

$$\frac{\dot{Q}}{Q} = \mu^* \quad \text{and} \quad \frac{\dot{G}}{G} = \frac{1}{1 - \beta_4} \gamma^*,$$

μ^* and γ^* denoting the remaining disembodied technical change. The effect of a hypothetical change to a policy which takes full advantage of new investment prospects from one which merely maintains a fixed stock is a $[1/(1 - \alpha_1)] (\mu^* + \alpha_1 \psi) - \mu^*$ rise in \dot{Q}/Q . The corresponding effect due to a similar change of policy in the case of a purely disembodied technology is $[1/(1 - \alpha_1)] \mu - \mu$. On the assumption that the anticipated rate is the same in both cases (thus, $\mu = \mu^* + \alpha_1 \psi$), the change in \dot{Q}/Q due to the change in policy is larger by $\alpha_1 \psi$ in the case of the partially embodied technical progress. This increment is that part of the rate of technical progress, μ , now ascribed to capital formation.

The Empirical Analysis

Data for a group of farms over the period 1936–1960 were used in the analysis. The group consisted of 33 *kibbutz* settlements which were established before 1936. This group was the entire *kibbutz* population of 1935, except for a few settlements which did not survive the 25-year study period.²

The production function and the capital variable

The analysis of capital formation and growth requires the estimation of an empirical production function. The function used was of the Cobb–Douglas form with year and farm effects:

$$(15) \quad X_{oit} = A_0 A_t A_i \prod_{k=1}^S X_{kit}^{\beta_k} \quad \begin{matrix} (k = 1, 2, \dots, S \text{ inputs,} \\ i = 1, 2, \dots, 33 \text{ firms,} \\ t = 1, 2, \dots, 25 \text{ years}), \end{matrix}$$

where

X_{oit} is the value of the gross farm output of firm i in year t , measured at the 1960 price level,

the X_{kit} 's are the inputs allocated in firm i in year t , including current expenditure on raw materials converted to the 1960 price level,

A_0 is a general constant term,

² The group studied constituted 14 percent of the Jewish farm population and produced 14 percent of the net value added of Jewish agriculture in Palestine in 1936. In 1960 the group produced 6 percent of the net value added of Israel's agriculture and accounted for 4 percent of Israel's farm employment [8].

A_t is a constant term of year t , and

A_i is a constant term of firm i .³

The capital variable used in the first stage of the empirical analysis is a gross stock estimate:

$$(16) \quad X_{1it} = \sum_j^M \sum_{v=T_j-t}^{t-1} I_{jiv}$$

where

I_{jiv} is gross investment expenditures on farm assets of type j in firm i in year v , converted to the 1960 price level by a price index pertinent to that particular type,

X_{1it} is the gross stock of farm assets in firm i in year t , and

$j=1, 2, \dots, M$ types of assets with a characteristic life span T_j .

Instead of the pattern of radioactive decay—that is, depreciation which is a constant fraction of the existing stock assumed above—here we are assuming depreciation by sudden death.

Constructing a series of equivalent capital inputs used in the second stage of the analysis, we find that the formula of imputation is identical with equation (16). Yet alternative investment series are employed, each of which corrected, according to equation (10), for an arbitrarily selected ψ , the rate of embodied technical progress:

$$(17) \quad X_{1(\psi)it} = \sum_j^M \sum_{v=T_j-t}^{t-1} I_{jiv}(1 + \psi)^v.$$

The production function and technical progress

On the assumption of a purely disembodied technical progress, the capital variable employed is the simple gross stock, X_{1it} . Equation (15) is identifiable with equation (2). Thus, the year constant, A_t , which, presumably, signifies the state of technology in year t , is expressed as

$$(18) \quad A_t = \bar{A}e^{\gamma t},$$

where γ is the rate of disembodied technical progress.

Adopting the concept of a partially embodied technical progress and an arbitrarily selected ψ , we find that the capital variable incorporated in equation (15) is $X_{1(\psi)it}$ and the remaining rate of disembodied technical progress replaces γ in equation (18).

The introduction of a new variable into the production equation, the "investment intensity factor,"

³ This analysis combines cross-section and time-series data. For a discussion of econometric aspects, see Hoch [3].

$$W_t = \frac{\text{average gross investment in year } t-1}{\text{average gross stock at the beginning of year } t-1},$$

enables us to accept the embodiment approach while rejecting the procedure requiring an arbitrary selection of ψ . The capital variable incorporated in the empirical production equation, in this case, is the simple gross stock, X_{1it} , and equation (18) is reformulated as follows:

$$(19) \quad A_t = A' e^{\gamma t + \psi W_t},$$

or, alternatively,

$$(20) \quad A_t = A'' e^{\gamma t + \delta(-1/W_t)},$$

or

$$(21) \quad A_t = A^* e^{\gamma t + \eta h_t},$$

where h_t stands for the age of the average asset in the gross stock looked upon as a weighted factor of investment intensity in the past.⁴

The embodiment approach is interpreted to mean that the level of the state of technology depends upon the intensity of gross investments, the underlying proposition being that a faster turnover of productive assets brings about a faster implementation of technological improvements. An alternative interpretation suggests that the insertion of the investment intensity factor merely mitigates the effects of errors in the measurement of a variable already present in the equation, namely, capital.

Consider, for instance, the reciprocal of factor W in a simplified stationary state. We are assuming thereby that the net investment is nil. Thus, I_v , in equation (16), is a constant, and T , denoting an average T , equals $1/W$. We accept equation (10) as relating the true value of gross investment to the observed gross investment figures. We also suggest that the ratio of the "true" stock—that is, the equivalent stock—to the gross stock may be taken to equal the ratio of the average observed investment to the average true investment in the existing true stock imputed as a geometric mean.

It could be shown that, under these assumptions, parameter δ in equation (20) above can be expressed as follows:

$$(22) \quad \delta = -\beta_1 \frac{\psi}{2},$$

where β_1 , we recall, is the production elasticity of capital and ψ is, presumably, the rate of embodied technical progress. Similarly γ , the rate of technical progress, can be expressed as

⁴ Note that

$$h_t \cong \sum_{i=1}^t \prod_{j=1}^i (1 - W_j).$$

$$(23) \quad \gamma = \gamma^* + \beta_1 \psi,$$

where γ^* is the remaining rate of disembodied technical change.

Empirical production functions with the simple gross stock variable

The estimated parameters.—Table 1 presents the least-squares estimates of the production elasticities for equation (15). The variables included in Regression 1 are the logarithmic value of the gross product as a dependent variable and the logarithms of the current expense, the gross stock of the farm capital, labor, and land endowments as independent variables. The gross stock of farm capital is replaced by the logarithmic values of farm plant and farm equipment in Regression 2. "Farm plant" includes all assets of which the life-span is longer than ten years, except, of course, land. "Farm equipment" includes all farm assets of which the life-span is longer than one year but shorter than, or equal to, ten years. The mean values for 1936

Table 1. Estimated production elasticities, geometric mean values, and annual rates of growth of *kibbutz* production, 1936–1960

Item	Regression coefficients		Annual rates of growth ^a	Geometric mean values		
	Regression 1	Regression 2		1936	1960	units ^b
Current expense	0.474 (0.026)	0.505 (0.026)	0.105	18	254	<i>thousands of dollars</i>
Equipment		0.030 (0.021)	.079	34	165	<i>thousands of dollars</i>
Plant		0.129 (0.028)	.101	61	650	<i>thousands of dollars</i>
Capital	0.242 (0.033)		.085	95	815	<i>thousands of dollars</i>
Labor	0.310 (0.031)	0.340 (0.031)	.044	27	95	<i>man-years</i>
Land	0.036 (0.013)	0.036 (0.013)	.064	212	766	<i>hectares</i>
Sum of regression coefficients	1.063	1.070				
R^2	0.9831	0.9825				
Gross product			0.115	35	553	<i>thousands of dollars</i>

^a These are least-squares estimates of the annual rates of growth for the equation $\ln X_{k,t} = m_0 + mt$, where $X_{k,t}$ stands for the annual geometric mean value of variable k .

^b Variables, presented in value terms, were measured in Israeli pounds at 1960 price levels and converted to U. S. dollars at the rate of 2.65 Israeli pounds per one U.S. dollar.

and 1960, the annual rates of growth of the output, and the various input endowments are also given in Table 1.

Explained and unexplained growth.—The pace of technical progress could be traced through the series of 25 consecutive estimates of year constants as suggested by equation (18). The year constants estimated for Regression 1 are plotted against the time variable in Figure 1 and indicate the secular trend.⁵ The corresponding estimate of the rate of disembodied technical change, γ in equation (18), was 0.0304. The rate estimated for the series of year constants obtained for Regression 2 was 0.0322. The two estimates imply that the annual rate of unexplained growth, attributed to disembodied technical progress, was approximately 3 percent. Not unexpectedly, by inserting the estimated elasticities and the corresponding rates

⁵ Note that the form of an exponential trend, in this case, is inferred from rather than imposed upon the empirical analysis.

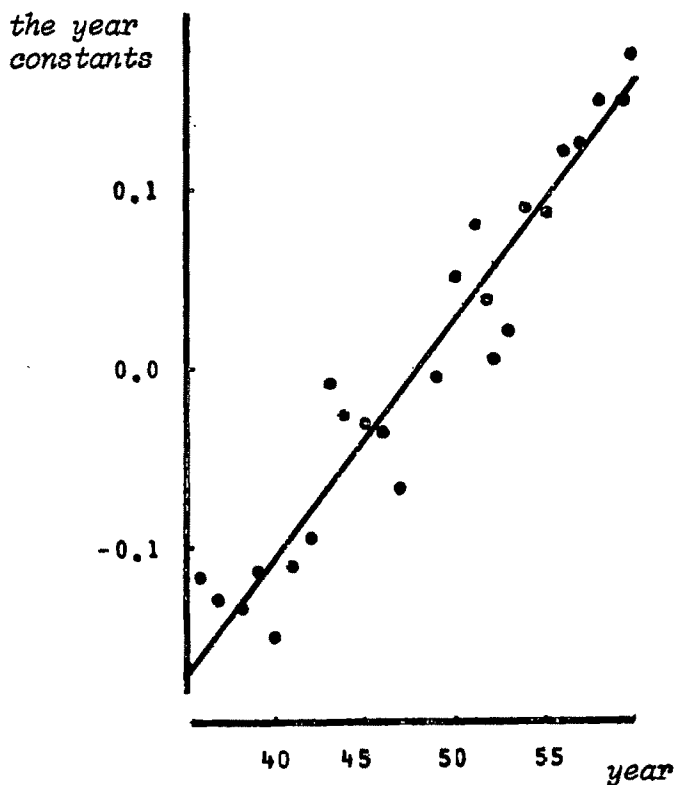


Figure 1. The pace of technical progress—the year constants correlated to time

of growth into equation (7) we could arrive at a similar estimate of γ . Approximately 2 percent of the 11.5-percent annual growth in the gross product is attributed, in terms of equation (7), to capital formation. The combined contribution of land and labor taken together amounts to 1.5 percent. Altogether, 8.5 percent of the annual growth in production is attributable to changes in the input endowments, including changes in current expense. Three percent of the 11.5-percent annual growth rate in production is undetermined.

The optimal growth rate.—As suggested by equation (8), the rate of capital stock is, indeed, higher than the weighted rate of growth of land and labor. Yet it clearly falls short of the rate of growth of the gross product, which, in its turn, falls short of the rate predicted by that equation. Inserting the estimated elasticities ($\hat{\beta}_k$'s) and the recorded rates \dot{N}/N and \dot{L}/L and $\hat{\gamma}$ into equation (8), we find that the predicted rate of growth of both the capital stock and gross product is 15.7 percent. The difference between the anticipated rate and the observed rates is attributable to a series of changes in R . The real external rate, R , was doubled from 1936 to 1960, mainly because of a decline in the portion of the credit allotted by the credit agencies, that is, b in equation (1). Considered within the framework of the simple equations presented in the previous section, an average annual rate of change in R of approximately 3 percent results in anticipated rates of growth of 12.5 percent in the gross product and 9.5 percent in capital. These figures fall in the vicinity of the ones reported in Table 1.⁶

Capital formation and technical progress

Production functions with equivalent capital.—Table 2 presents the results of the attempt to incorporate equivalent capital variables, imputed according to equation (17), in the regression analysis. It must be pointed out that alternative capital variables were found to be highly correlated with one another.

As can be expected, the estimated production elasticity of capital declines as the assumed rate of embodied technical change increases. As a result, unexplained growth or disembodied progress disappears only when the assumed rate of change is quite artificially set at 30 percent. Another aspect of the decline of estimated elasticities is reflected in Table 3, which compares the series of estimated elasticities and the geometric means of the corresponding capital variable in the mid-period year (1948). The two are definitely proportional; hence, following equation (12), we find that the estimates of the marginal returns obtained for variables with different rates

⁶ There is good reason to believe that changes in R were unforeseen, at least until the late fifties. Correcting for these changes, we add $[-\beta_1/(1-\beta_1-\beta_4)](\dot{R}/R)$ to equation (8) in order to predict \dot{G}/G . For predicting \dot{K}/K , the necessary addition is $[(\beta_4-1)/(1-\beta_1-\beta_4)](\dot{R}/R)$.

Table 2. Production elasticities obtained for equations including "equivalent" capital variable with alternative rates of embodied technical progress^a

Regression	Assumed annual rate of embodied technical change	Regression coefficients for				Sum of regression coefficients	R ²
		current expense	capital	labor	land		
1	0.00	0.475	0.242	0.310	0.036	1.063	0.9831
12	.02	.483	.232	.310	.036	1.061	.9829
14	.04	.488	.216	.312	.036	1.052	.9829
16	.06	.490	.202	.314	.036	1.043	.9828
18	.08	.492	.191	.316	.037	1.036	.9827
110	.10	.493	.181	.318	.038	1.030	.9827
.
120	.20	.500	.150	.323	.039	1.012	.9825
130	.30	.506	.132	.327	.040	1.005	.9824
140	.40	.510	.121	.330	.040	1.001	.9824
150	0.50	0.514	0.112	0.331	0.040	0.997	0.9823

^a All the equations allow for firm and year effects.

Table 3. A comparison of the estimated production elasticities, the geometric means, and the marginal returns imputed for the mid-year period, 1948

Item	Assumed rate of embodied technical progress									
	0.00	0.02	0.04	0.06	0.08	0.10	0.20	0.30	0.40	0.50
Equivalent stock in 1948 ^a	887.2	797.5	719.6	671.0	628.6	593.7	481.8	428.9	389.3	366.5
Elasticity of capital ^b	0.241	0.232	0.216	0.202	0.191	0.181	0.150	0.132	0.121	0.112
Estimated gross marginal returns ^c	0.101	0.108	0.111	0.112	0.113	0.113	0.116	0.116	0.115	0.114

^a Measured in terms of the productive capacity of a current investment unit.

^b From Table 2.

^c The external rate, R , in 1948 amounted to 0.107, consisting of a depreciation rate of 0.058 and a rate of interest of 0.049.

of embodied technology are virtually identical with the one obtained for the zero rate variable.⁷ The zero is the only rate of embodied technical progress resulting in an estimate of marginal returns consistent with the corresponding external rate.

A direct approximation of ψ .—Unable to determine ψ indirectly, that is, through the series of iterations, we venture another attempt to gauge the

⁷ This result is by no means inherent in our model. Note that the variables in our regression analysis are the logarithms of the observed variables. Let $\bar{X}(0)$, etc., stand for the geometric means of the dependent variable and the two alternative independent variables in the relationships $X(0) = X(1)^\beta$ and $X(0) = X'(1)^{\beta'}$, respectively. Also, let $Z(0)$ stand for $\log X(0)$, etc. A linear relationship in the logarithmic form of the two alternative independent variables, that is, $Z(1) = qZ'(1)$, does imply that $\beta' = (1/q)\beta$, but not that $[\bar{X}(0)/X(1)]/[\bar{X}(0)/X'(1)] = q$.

magnitude of the rate of embodied technical progress within the framework of equations (19) to (23).

The estimates of the parameters of equations (19) to (21), including a version of equations (19) and (20) which allows for separate intensity factors for plant and equipment, are presented in Table 4.

Table 4. The coefficients of technical progress and investment intensity^a

Re- gres- sion	Techno- logical improvement γ	Investment intensity						Age of assets σ	R^2
		Total investment		Plant		Equipment			
		ϵ	δ	ϵ'	δ'	ϵ''	δ''		
3	0.0329 (0.0021)	0.2094 (0.0923)							0.9223
32	0.0339 (0.0021)		-0.0083 (0.0043)						.9275
33	0.0396 (0.0057)							-0.0273 (0.0197)	.9223
41	0.0344 (0.0021)			0.1294 (0.0657)		0.0827 (0.1728)			.9317
42	0.0330 (0.0021)				-0.0059 (0.0031)		-0.0043 (0.0027)		0.9261

^a Excluding t , the independent variables were annual averages, the dependent variable being $\ln A_t$. This estimation procedure rules out variation and cvariation within years. Imposing a restriction $A_t = 0$ and inserting t and variable W_{it} into equation (15) allows us to estimate simultaneously the coefficients γ , t , and ϵ , and the elasticities of production. The estimated parameters were as follows:

Regression	Current expense	Capital	Labor	Land	$\hat{\alpha}$	$\hat{\beta}$
130	0.565 (0.023)	0.206 (0.031)	0.266 (0.031)	0.035 (0.013)	0.184 (0.097)	0.028 (0.002)
131	0.563 (0.023)	0.199 (0.031)	0.245 (0.027)	0.037 (0.013)		0.029 (0.002)

The impact of investment intensity appears to be quite significant. For instance, doubling an investment-intensity ratio of 0.05 is supposed to result in a level of production which is higher than a corresponding level obtained for an identical bundle of inputs during the same year. The difference amounts to a mere 1 percent according to Regression 31 but to 8 percent according to Regression 32.⁸ If the old ratio has been maintained for a long enough period—for instance, ten years—the immediate impact amounts to 5 percent, according to Regression 33.

Strictly, the interpretation of δ formulated by equation (22) applies only in the particular case stated above. Yet venturing an attempt to gauge the magnitude of ψ , we arrive, following Regression 32, at the estimated rate $\hat{\psi} = -2\delta/\hat{\beta}_1 = 0.07$. The observed rate γ , interpreted accordingly, is divided, following equation (23), into two: one half, that is, 1.7 percent, is attributable to capital; the other half remains unexplained. Although this observa-

⁸ Also, $\epsilon = [\delta X_0 / \delta(d)] [1/X_0]$, the gross stock remaining constant, where d stands for the depreciation rate. It may be envisaged, therefore, as an output-replacement coefficient indicating the percentage change in output due to a change in the rate of depreciation.

tion is consistent with the embodiment proposition, it does not necessarily prove it. The introduction of the investment-intensity factor might have mitigated the effect of errors in the capital variable other than the neglect of embodied technology; a major source of such errors is, as suggested by Jorgenson [4] and Jorgenson and Griliches [5], the inevitably wide application of index numbers in the empirical work.

For instance, the ratio of the investment price index to the farm product price index used in this study grew annually at a rate of 4 percent. To the extent that this phenomenon reflects an error of measurement which is positively associated with time, it may have resulted in an error in the capital variable of the type mentioned above.

Quantitative changes in the labor endowment

The coefficient A_i (the farm constant) in the production equation (15) reflects, among other things, the firm's managerial capacity. Holding the A_i 's constant through time, we are implicitly assuming a constant managerial capacity. This strong assumption may be replaced by a weaker one suggesting that the relative capacity remains constant, that is, A_i/A_i' is constant for any pair of farms among the 33 farms studied; the absolute level of A_i is subject to changes through time. Probably

$$(24) \quad A_{it} = A_{i0}e^{\lambda t},$$

A_{it} denoting the i th farm constant in year t .

Although it was almost impossible to test this proposition with the time-series data at our disposal, it could be examined in a cross section covering three-quarters of the entire *kibbutz* population in the years 1958–1960. The enlarged sample contains the 33 farms studied in the previous sections. These farms, established before 1936, were, on the average, 30 years old in 1958. The cross section also includes a group of 64 "young" farms established after 1947 and a group of 80 "intermediate" farms established after 1935 but before 1948. In 1958 the average young farm was 10 years old and the average intermediate farm was approximately 18 years old.

A group constant, A_g , can be substituted for the farm constant, A_i , in equation (15) and estimated by using the data collected in the enlarged cross section. An examination of the estimated group constants reveals that these are positively associated with the corresponding age of the average farm⁹:

⁹ The estimated elasticities were as follows:

Current expense	Capital	Labor	Land	R^2
0.647 (0.033)	0.225 (0.030)	0.226 (0.029)	(0.010) (0.013)	0.915

Group	Age	Group constant (\hat{A}_0)
Old	30 years	1.068
Intermediate	18 years	1.006
Young	10 years	0.960

This relationship undoubtedly reflects a variety of factors, including, for instance, differences in location. Yet we are inclined to believe that experience is a dominant factor in this respect. The magnitude of λ in equation (24), which is consistent with the three pairs of figures presented above, is 0.005. Considering this rate as a crude estimate of a coefficient of learning, we can say that approximately one-sixth of the estimated rate of technical change, $\dot{\gamma}$, or one-third of the remaining rate, $\dot{\gamma}^*$, is ascribable to improvements in management or qualitative changes in the labor force.

The pace of growth beyond 1960

Applying the parameters derived from the analysis of the 25-year period 1936–1960, to the 1961–1965 land, labor, capital, and expense figures of the group of 33 farms under study, we arrive at the anticipated gross product figures compared with the observed figures in Table 5.

Table 5. Estimated and actual gross product: the average farm firm 1961–1965^a

Year	Anticipated figures			Actual figure
	Estimate 1 ^b	Estimate 2 ^c	Estimate 3 ^d	
1961	1.079	1.062	1.064	1.085
1962	1.201	1.176	1.177	1.192
1963	1.244	1.209	1.201	1.209
1964	1.295	1.251	1.254	1.274
1965	1.404	1.350	1.336	1.415

^a Anticipated and actual figures are presented as percentages of the corresponding 1960 figures. The absolute figures in the base year in thousands of U.S. dollars were 580 for estimate 1, 564 for estimate 2, 549 for estimate 3, and 553 for the actual gross output.

^b Imputed according to the parameters of Regression 1, assuming $\gamma = 0.03$.

^c Imputed according to the parameters of Regression 18, assuming $\psi = 0.08$ and $\gamma^* = 0.017$.

^d Imputed according to the parameters of Regression 1, assuming $\psi = 0.08$ and $\gamma^* = 0.015$.

Contemplating a purely disembodied technical change, we arrive at estimate 1 in this table. Adopting the parameters and the measurement of the capital variable which are consistent with the embodiment hypothesis, we arrive at estimates 2 and 3.

We note that the estimated and the actual figures fall very close to each other. Since the sum $\gamma^* + \beta_1\psi$ in estimates 2 and 3 is approximately 3 percent, which in turn is the rate of progress, γ , underlying estimate 1, and since the

farm firm under study is assumed to be a profit maximizer, the similarity reflected in Table 5 is not unexpected.

Conclusions

The analysis of the pattern of growth of the Israeli *kibbutz* farm suggests that 10 to 10.5 percent of an observed annual 11.5-percent rise in the farm gross product is attributable to quantitative and qualitative changes in the input endowments. Capital formation appears to be the crucial element. An attempt to gauge the real contribution of capital formation indicates that 2 percent of the annual 11.5-percent rise in the level of production could be attributed to capital. This contribution is comparable with 1.5 percent attributed to land and labor taken together, 5 percent attributed to the extended utilization of raw materials, and 3 percent attributable to technological improvements. Furthermore, a closer examination reveals that a considerable portion, approximately one-half, of the last item is apparently associated with capital or capital formation, probably as a result of technological improvements carried through the flow of gross investments.

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Why Peasant Farmers Borrow

MILLARD F. LONG*

Interest rates are high in the rural credit markets of poor countries. Yet it is often said that the rates of return on capital invested in traditional inputs is low. Under these conditions it would seem uneconomic for farmers to borrow; if funds are needed, farmers should sell assets. If the expected costs are greater than the expected benefits, farmers will not have as much incentive to borrow money. Indeed, the evidence suggests that in poor countries most farmers are free of debt. But there is great diversity; some farmers do have high marginal returns on capital; some borrow at low rates; seasonality influences the debt structure, as does the level of wealth; and transactions costs may make borrowing cheaper than selling assets. Introducing uncertainty reduces the chances that farmers will borrow.

IN *Transforming Traditional Agriculture* [13], T. W. Schultz argues that many writers have mistakenly suggested that in peasant agricultures labor is so plentiful as to be redundant whereas capital is quite scarce.¹ Schultz does not accept the notion of hidden unemployment and suggests that on capital the marginal return, at least when invested in traditional as distinct from modern inputs, is low, probably of the order of 3-5 percent per year. My analysis in this article applies to either high or low returns to capital in traditional agriculture; however, it provides a basis for rationalizing within Schultz's basic framework a conundrum which he does not adequately explain: If the return on capital is low, why do farmers borrow at the high interest rates we know to prevail in many rural credit markets?

Schultz deals with this issue only in passing:

The factual question of the net rate of return that money lenders obtain will be held in abeyance, although what is charged and what is collected under these circumstances could make a large difference. Suppose, however, that the net rate were inordinately high by normal standards but that these loans were used predominantly to straighten out the consumption streams of particular families who were not demanders of reproducible material capital and of land as sources of permanent income streams. Suppose also that the loans were not used to invest in human capital. The market for consumption loans could be a different market from that for the permanent income streams under discussion. Furthermore, even when there are some loans strictly for agriculture production, some of these may entail high risk uses of funds, and for these it is to be expected that the charges of the money lender would be high [13, p. 86].

* I wish to thank James Kindahl, Jere Behrman, Howard Kunreuther, Eugene Smolensky, and the reviewers for this journal for telling me what was wrong with an earlier draft of this article. What remains incorrect is my responsibility.

¹ Some of the more important contributions to this debate include Eckhaus [8], Leibenstein [7], Lewis [8], and Ranis and Fei [12]. Paglin [10] recently completed a study of Indian agriculture which supports Schultz's thesis on labor employment, but Paglin's interpretation has been questioned by Bennett [2].

Schultz's paragraph is somewhat difficult to interpret, mixing as it does the reason why lenders charge high rates (because default substantially reduces the lender's realized return) with the explanation of why farmers are willing to borrow at rates many times what, he asserts, they can earn on capital. Farmers cannot, as Schultz suggests, be separated into those who produce and those who consume²; and any farmer with some capital of his own has, as an option to borrowing, selling low-yielding assets to finance his consumption. If borrowing is frequently undertaken by producing farmers with capital of their own, then presumably the expected advantages are as great as the cost of the loans.

The role of borrowed funds can best be understood in the context of farm decision making on the allocation of capital. Farming combines the dimensions of the firm and of the consumer: a farmer's decisions encompass the allocation of wealth between present and future consumption, the choice between holding capital in risky and less risky forms, and the allocation of time between labor and leisure. A decision to consume more today means a reduction in owned capital. This can imply any combination of the following: (a) less future consumption, (b) more work to offset the loss of capital, and (c) the holding of a riskier but possibly higher-yielding portfolio. In the present analysis of farm credit, the farmer's four choices are reduced to two; if we presume that the labor-versus-leisure and present-versus-future-consumption choices³ have already been made, the demand for credit is considered as a question of allocating capital in an action space which has only yield and risk for its dimensions. In the first section, the problem is reduced to one of choice among assets with known yields; in the second, it is expanded to include allocation under uncertainty. The third section is devoted to an empirical analysis of farm borrowings, based primarily on Indian data, to test how well the theoretical model can explain observed behavior; the fourth section contains the conclusions.

As a setting for the problem, it is assumed that the major crop is an annual, such as rice, harvested once during the year; that in a normal year the farmers under consideration produce more of the major crop than is needed to feed their families; and that they have access to markets in which surplus production, factor inputs, and assets such as land can be bought or sold.

² As it stands, Schultz's argument is incomplete; he needs to add that producers do not lend to consumers, for lending as well as borrowing could equate on the margin the returns from lending and production. Schultz suggests in the last sentence of the paragraph that, in addition to consumption loans, producers may also borrow for "high risk uses of funds." Though he does not say so, presumably these high risk uses also promise high returns to the borrower, or he would not be willing to pay the high rates.

³ The problem of time paths has been assumed away by separating the consumption and portfolio decisions and allowing the trading of assets at the end of each time period. For an article which does discuss investment and consumption choices over the course of time, see Hirshleifer [5].

Borrowing Under Certainty

We assume that the farmer's objective under conditions of certainty is to allocate his present wealth so as to maximize the wealth available to him at the end of the production period. If changes in the value of assets are included in income, the problem can be treated as one of maximizing income. In the situation under consideration, the farmer is viewed as investing his original wealth (\bar{W}) in production capital (C) in order to maximize his income (Y). If opportunities justify the action, the farmer can increase his capital holdings by borrowing (B); if opportunities are unfavorable, he may choose to hold part of his wealth as cash (M). This last option will become more relevant in the next section; under conditions of certainty, the yield on holding money is zero.

Figure 1 depicts these conditions for a typical farmer operating in a traditional agriculture. The marginal-efficiency-of-capital schedule (MEC) has been drawn to indicate decreasing returns to additional holdings of production capital (C) on the assumption that the farmer's managerial talents are limited and he cannot purchase more on the market. Production capital, as defined here, includes not only land and farm implements but also the liquid assets held as working capital at the onset of the production

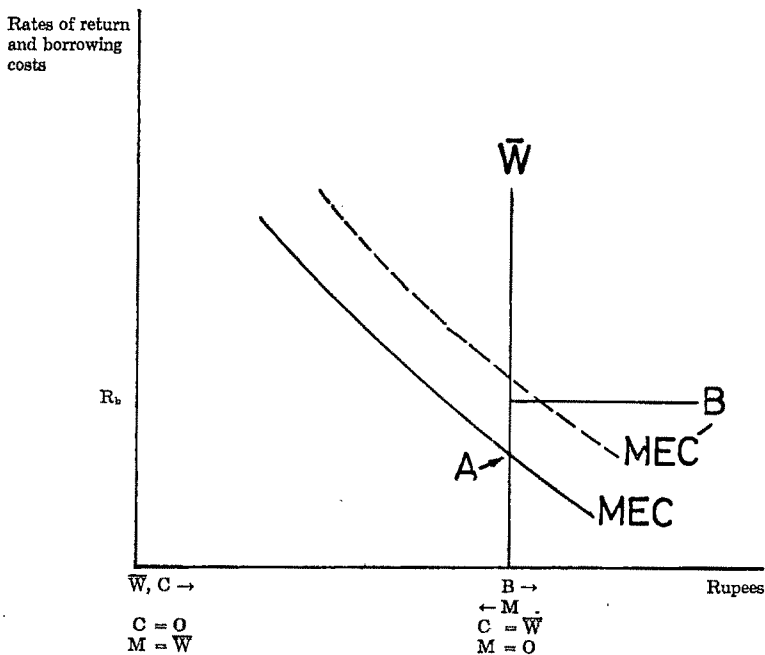


Figure 1. Borrowing under certainty

cycle⁴ and, in a sense, turned into field crops as the growing season progresses. The borrowing schedule (B) indicates the cost of debt. The line \bar{W} indicates the farmer's initial endowment of wealth; the amount of borrowed funds is measured from the line \bar{W} as axis to the right. If the return on production capital fell to zero before the total investment of the farmer's wealth, the remainder would be held as cash (M), measured from \bar{W} as axis to the left.

Farmers might be considered as having another option, that of making loans. In fact, in developing countries farmers are often constrained in lending by family obligations which may require them to lend available funds to family members but preclude their charging the market rate of interest. But even if they do lend at going rates, there is a difference, because of administrative costs and risk premiums, between the rate they must pay as borrowers and what they can earn as lenders. This perhaps explains what we observe in developing nations, that many farmers neither borrow nor lend⁵: at the point where their entire wealth is invested in production capital ($\bar{W} = C$), the marginal rate of return on this capital is greater than they could earn on loans but less than they would have to pay as borrowers. It is not difficult to incorporate lending into the formal analysis; in the certainty case under consideration, the farmer would lend if the marginal return on production capital fell below the return on loans for values less than his original wealth endowment. But because we are here concerned with how farmers borrow and not with why they lend, I will limit consideration to the simple model in which holding cash is the only alternative to investing in production capital.

To maximize his income, the farmer would equate the marginal return on capital invested in production with the costs of borrowing:

$$\max Y = P \cdot q(C) - g(C) - R_b B$$

subject to $\bar{W} = C - B$,

where

P is the price of the output,

$q(C)$ is the amount produced,

R_b is the interest rate on borrowed funds,

b is the amount borrowed, and

$g(C)$ is operating costs, including an allowance for the depreciation of capital.

If $dY/dC > R_b$ at $\bar{W} = C$, the farmer will borrow; if $dY/dC < R_b$ but greater

⁴ It is assumed that the farmer, knowing the prices of factors, has made the optimal allocation between physical capital and other inputs.

⁵ Penny [11] claims that subsistence farmers have a strong dislike for either borrowing or lending.

than zero at $\bar{W}=C$, the farmer will neither borrow nor hold cash but will invest all his wealth in production capital.

It is this last situation which is depicted in Figure 1; income is maximized by putting all wealth into production capital (shown as point *A*). Although Schultz's model, unlike the one given here, is not free of uncertainty, the situation depicted accords with his view of conditions among farmers in traditional agricultures: the average individual is not borrowing to finance new projects because over the long, relatively static past all investments yielding high returns have been undertaken.⁶

But in fact within the farming community there is considerable heterogeneity: new families and farms are continually being formed; on older farms, sons may be better or worse managers than their fathers; prices of both inputs and outputs fluctuate; and, as suggested in the next section, the vagaries of nature cause both expenditures and outputs to differ from their expected values. As a result of the diversity of conditions, some farmers undoubtedly find it profitable to borrow. Consider the following cases: (1) If, with the same wealth and the same cost of debt as the farmer depicted in Figure 1, another farmer had ways to use capital that were more productive, he might borrow. Better management, a change in the regional terms of trade, new opportunities, any one of these might cause the *MEC* curve to be displaced far enough to the right to make borrowing profitable. (2) A farmer who could obtain funds at lower rates (from a government agency, for example, or a relative)⁷ might find he could raise his income by borrowing. A downward shift in the *B* curve in Figure 1 suggests that farmers will borrow more at lower interest rates. (3) In a seasonal agriculture the alternative to borrowing during the growing season is to start the year with enough working capital to meet all outlays between the planting of a crop and its sale. Short-term borrowing, although expensive, may be preferable to holding that much working capital; for example, it would pay a farmer to borrow for one month at a 50-percent annual rate⁸ if as a result he could switch working capital into physical capital yielding 5 percent per year. The rate variables for *B* and *MEC* in Figure 1 reflect analogous time periods; introducing loans of shorter duration than a crop year could be depicted as lowering the cost of borrowing. As noted in the third section, many agricultural loans are indeed for periods of less than one year. (4) A newly established farmer with the same opportunities (the same production function) as others but with little wealth might also find it advantageous to borrow. This situation would be depicted by a leftward shift of the \bar{W}

⁶ The data cited in the third section support this view as descriptive of the conditions of many Indian farmers.

⁷ Relatives frequently lend to each other at no charge or low rates of interest. Lending within the extended family may be a form of mutual insurance.

⁸ Of course, once administrative costs and risk losses have been subtracted, the yield to the lender will be much less than 50 percent.

line in Figure 1, the other curves remaining unchanged. (5) Transaction costs may make borrowing a cheaper way to adjust to short-run changes than selling assets, even though on the margin the annual return to the asset is less than the costs of borrowing.⁹ This is especially true if the asset is likely to be repurchased. If, as is likely, there are economies in farming contiguous pieces of land, a farmer will be averse to selling acreage if he is not certain that he can repurchase land in the same area at a reasonable price.

Tenancy and poverty are often said to influence a farmer's debt position. Though frequently found together, these two factors can be separated conceptually. Tenancy is discussed here; poverty is postponed to the next section. If tenancy takes the form of sharecropping, with the landlord receiving a fraction of the output in return for the use of land, the marginal return on capital to the cultivator will be smaller than if he owned the land himself.¹⁰ However, the rented land represents wealth additional to his own over which the farmer has controls. In Figure 1, this position would be depicted by a leftward shift in the *MEC* curve and a rightward shift in the *W* schedule. The two effects are additive, both working to reduce the amount of borrowed funds. The predicted effect of tenancy, other things held constant, is to reduce, not increase, the amount of debt. For a farmer who wants to work more land than he owns, renting is a substitute for borrowing to buy land.

Borrowing Under Uncertainty

The vagaries of nature make agriculture a very uncertain business. Both output and expenditures are subject to random fluctuations,¹¹ and this uncertainty will influence the farmer's choice of portfolio.¹² In this section, we will examine the selection of an *ex ante* portfolio, that is, the portfolio chosen before the growing season but subject to change during the season if, say, expenditures or production are different from those expected.¹³

⁹ If transaction costs are 5 percent both on purchase and sale of an asset, and if the asset will earn 20 percent on an annual basis, and if the farmer's cash needs are for six months or less, it is better to borrow than to sell the asset if the interest rate is below 40 percent per year.

¹⁰ Presumably the farmer will desire his investments to pay a profitable return during the life of his lease. If on termination of the existing lease the renter can be dispossessed, he will not undertake investments which will only pay off over a long period, unless the investment is in a movable object. Where the land rental is fixed in amount, renting shifts the farmer's average product curve without affecting his marginal return.

¹¹ It makes little difference to the discussion whether household expenditures are included in costs; but part of consumption outlays—for example, ceremonial expenditures resulting from the death of a family member—are subject to random disturbances.

¹² The literature on this problem is very extensive; see, for example, Farrar [4] and Hirshleifer [5] and the references which they cite. The presentation given here and the problem discussed are most closely associated with Tobin [15].

¹³ In the remainder of the discussion, attention will be concentrated on expenditures. Randomness in output can be handled by assuming compensating expenditures; for example, to offset a crop failure, a farmer could purchase output equal to the difference between actual and normal production.

The farmer's concern is to allocate a given amount of wealth, possibly supplemented by borrowing, between production capital and money (M). Under conditions of uncertainty, holding cash *ex ante* is likely to be economical because, unlike funds invested in production capital, money can be used to meet unexpected outlays and thus avoid the costs of illiquidity, which in this model are taken to be the costs of borrowing.¹⁴ On the other hand, the cost of holding money *ex ante* is the income foregone on production capital. The need to hold money depends upon the variation in the difference between income and outlays. In the model, only liquid assets that the farmer intends to hold throughout the year are treated as money; as in the first section, funds held to meet expected outlays during the growing season are included in production capital. It is assumed in the model that when expenditures *ex post* differ from planned outlays, the difference is met by a change in cash holdings. If available funds are inadequate to meet unexpected outlays, the remainder is borrowed¹⁵; if the farmer has surplus funds *ex post*—that is, funds not needed to meet expenditures—these are used to repay any outstanding debts, with the excess being held as cash until the end of the production period. For the next production period, the farmer can reallocate all the assets in his portfolio.

The problem, then, is seen as maximizing the following function:

$$\max E(Y) = P \cdot q(C) - g(C) - \int_M^{\infty} r(S - M)(S - M)f(S)dS,$$

subject to $M = \bar{W} - C$.

The symbols have the same interpretation as in the first section; of the new

¹⁴ Conceptually, this argument is analogous to Keynes's precautionary motive for holding cash: "To provide for contingencies requiring sudden expenditures and for unforeseen opportunities of advantageous purchase . . . are further motives for holding cash. . . . If deposit interest is earned or if *bank charges are avoided by holding cash* [*italics mine*], this decreases the costs and strengthens the motive" [6, p. 196]. One of Keynes's other reasons for holding money—cash kept for transactions purposes, that is, to meet expected outlays—has been handled in this article as part of production capital. Holding cash for speculative purposes, Keynes's third reason, is not discussed in this article, but speculation could be treated as affecting the attractiveness of holding cash compared to production capital. Tokin draws a distinction between cash held for transactions purposes and cash held for speculative purposes: "In contrast to transactions balances, the investment balances of an economic unit are those that will survive all the *expected* [*italics mine*] seasonal excesses of cumulative expenditures over cumulative receipts during the year ahead. . . . If cash is to have any part in the composition of investment balances, it must be because of expectations of fears of loss on other assets" [15, p. 66]. But the precautionary motive noted here implies that there is yet another reason why cash is held in investment balances, which are expected to survive seasonal changes in expenditures and receipts; it is that income may be enhanced by making provision for the variations in transactions outlays. A recent treatment of the precautionary motive for holding cash, similar to that presented here, is to be found in Whalen. He argues that optimal cash holdings for precautionary purposes vary "in proportion with the cube root of (1) the variance of the distribution of net disbursements, (2) the cost of illiquidity, and (3) the reciprocal of the opportunity cost rate" [16, pp. 318–319].

¹⁵ Actually, the farmer's response to an event need not be independent of his portfolio holdings. No attempt has been made to build this refinement into the model.

symbols, $E(Y)$ is expected income; S is the random expenditure variable, with mean zero and distribution $f(S)$; $r(S-M)$ expresses the interest rate as a function of the amount borrowed. As shown in Figure 2, the interest rate is presumed to rise with higher debt-equity ratios because of the greater possibility of default. $\bar{W} - C$ can take on negative or positive values; it is negative when the farmer is an ex ante borrower and positive when he is holding cash. To maximize expected income, the farmer would equate the marginal return on production capital, $\partial E(Y)/\partial C$, with the expected costs of borrowing, $\partial E(Y)/\partial M$, or, what is the same thing, the expected savings from holding cash.¹⁶ There are diminishing returns to holding cash ex ante, because both the size of the expected borrowing ($S-M$) and the rate of interest $[r(S-M)]$ which the farmer expects to pay if he borrows decline as cash holdings increase.

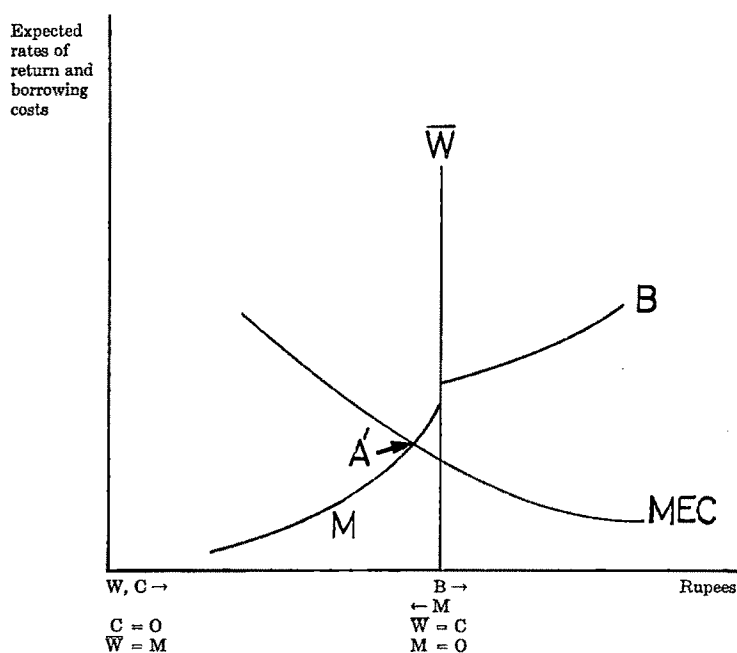


Figure 2. Borrowing under uncertainty

How these considerations affect the farmer's ex ante portfolio choices is shown in Figures 2 and 3. Figure 2 depicts the relationship between asset holdings ex ante and expected returns; it indicates the ex ante portfolio that would be selected by an income-maximizing farmer. The effect of risk is to give ex ante monetary holdings a positive expected return, because in

¹⁶ Again, it is not difficult to include lending in the model as an alternative asset. The farmer's choice in this case is among production capital, debt, loans, and money.

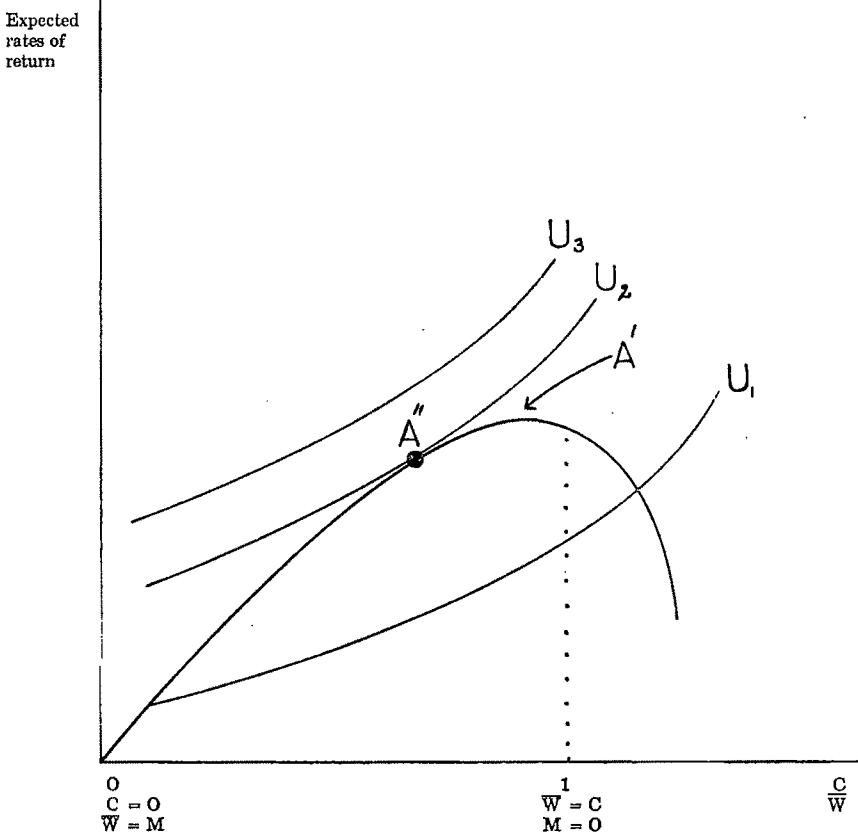


Figure 3. Borrowing with risk aversion

the absence of cash holdings the farmer will be forced to borrow ex post if expenditures are greater than anticipated. Risk also increases the cost of borrowing by adding a risk premium to the lender's charges; this premium is depicted as increasing with the debt-equity ratio. In Figure 2 the farmer would maximize expected income by holding part of his wealth in production capital and the rest in cash reserves (as shown by the point A').

A farmer who was a risk averter would hold more cash and less production capital in his ex ante portfolio than the combination expected to maximize income. To show the effects of risk aversion, the expected yield information in Figure 2 has been translated into a third figure, which relates the farmer's expected return to the combination of assets he chooses to hold. In Figure 3, movement to the right along the horizontal axis indicates an increasing proportion of wealth held in the form of production capital. Holding more capital (and less money) increases the risk and the yield up to a point; beyond that point, risk continues to rise but yield falls.

The origin of the axis represents a portfolio consisting of all cash and no production capital; point 1 represents a portfolio in which all the farmer's own wealth would be in production capital and none in money; and points to the right of that represent portfolios containing additional production capital financed by borrowing. The yield curve is concave from below because of the diminishing returns on both production capital and money and is supposed to represent conditions analogous to those depicted in Figure 2.

The farmer is presumed to be a risk averter, trading off yield against risk; the indifference curves are ranked in order of increasing levels of utility.¹⁷ For the conditions depicted, the ex ante portfolio which would maximize expected utility (A'') contains more cash and less production capital than that which would maximize expected income (A'). Introducing uncertainty and risk aversion into the model reduces the amount of production capital which the farmer would choose to hold in his ex ante portfolio and increases the amount of money.¹⁸ The results are similar for a farmer who under conditions of certainty would be a borrower; under uncertainty he might still borrow, even if he is a risk averter, but his ex ante portfolio would contain less debt and less production capital than under certainty.

Although the considerations raised in this section, uncertainty and risk aversion, make it less likely that farmers will hold debt in their ex ante portfolios, these factors do point to another and quite important reason why farmers borrow. Ex ante, it is not profitable for farmers to hold sufficient cash to meet every possible contingency. When adverse events require expenditures greater than cash reserves, farmers must go into debt. In a traditional agriculture, ex post borrowing to meet unanticipated contingencies accounts for a large fraction of the debt of small farmers.

To disentangle the complex relationship between poverty and debt, it is useful to distinguish among three different situations: farmers whose incomes are low only because they have had a bad harvest, farmers who are poor because they have fewer resources than their neighbors, and farmers who are poor because high interest payments absorb much of their income.

¹⁷ The risk on the portfolio is assumed to be associated with the variance of the yield, which increases with greater holdings of the risky asset, that is, with movement to the right in Figure 3. A more realistic treatment would assume that the farmer balanced wealth, not yield, against risk. The treatment of tastes toward risk presented here follows Tobin [15]; for a more complete discussion, including the case of the investor who prefers risky situations, see his article. In addition to the solution depicted in Figure 3, Tobin deals with corner solutions in which the portfolio chosen would contain only one asset. He also develops the conditions under which a preference map relating yield and variance makes sense.

¹⁸ Although separately either uncertainty with profit maximization or risk aversion would reduce (or leave unchanged) the amount of production capital held in the selected portfolio, the two factors acting jointly could cause the farmer to choose a portfolio containing a larger share of production capital. The result would depend upon the shape of the utility surface. Uncertainty reduces the expected yield; to maintain income, the farmer might opt for a more risky portfolio.

As discussed above, for those who are poor only because of temporary adversity, borrowing may be a better way to adjust than selling assets.¹⁹ For those who have good opportunities but limited wealth of their own, borrowing provides the opportunity to add to capital and thereby increase income; only if these farmers have strong preferences for current consumption will they fail over the course of time to accumulate wealth. On the other hand, if the resource which the farmer lacks is managerial talent, he is likely to remain poor.

It is said of some farmers that they are poor only because so much of their gross receipts goes to repay the interest on loans. Yet being able to borrow has probably improved their income position. For example, if the borrowed funds are invested in production capital, the debt presumably adds to the farmer's expected income or the project would not have been undertaken. But even if debt is used to finance consumption or ceremonial outlays, it adds to income if the expenditures would otherwise have been financed by selling assets yielding a higher return than the borrowed funds. Only if the alternative to debt is not making the consumption outlay does past borrowing reduce present income.

Empirical Evidence

The model described in the preceding sections has many behavioral implications. For example, from knowledge of the farmer's portfolios, his expected returns on different assets, and his prior probability distribution of relevant events, it should be possible to determine his risk preference; or, conversely, given his risk preference, portfolio, and expected returns, one could deduce his expectations about the uncertain future. No data were available on which to attempt so sophisticated an analysis; rather, in this section, I shall simply try to determine how much of the differences in debts among 9,000 Indian farm families can be explained by surrogate measures of some of the concepts suggested by the model. The information was drawn from a national survey of Indian farmers made in 1951-52; the reported data [1] had already been aggregated by district and value of farm product into 672 subclasses; the proportion falling into each subclass was reported and was used as a weight in the regressions.

Unfortunately the data permitted only a crude test of the model. For many of the model's variables there were no available empirical counterparts. For example, it was not possible to find in the data constructs which would measure either transaction costs or risk aversion. On the other hand, a fairly good indicator of wealth was available—the value of capital assets owned less outstanding debt. The interest rate paid by each class of borrower was not reported, but there was information on rates by district and

¹⁹ To maintain consumption in spite of short-run income changes is the reason for borrowing given by Schultz in the paragraph quoted on the first page of this article.

by farm size. Ex post borrowing may take place if expenditures are unexpectedly high or if income is less than anticipated. The ratio of gross product to the value of land was employed to measure the latter, on the presumption that the price of land, being the present value of expected future returns, was reasonably well correlated with anticipated returns. This ratio, then, purports to measure the relation of actual to anticipated income and is referred to below as the index of transitory income. Both numerator and denominator of this variable are suspect. Net rather than gross product is the relevant measure of "actual" income, and the price of land reflects only the residual return to the land, not total income. A better measure of this concept might well have shown greater statistical association with outstanding debt. It was not possible to ascertain whether the farmer's expenditures were unusually high in the period under consideration; rather, the sum of outlays on ceremonies and soft goods²⁰ was taken as the expenditure variable. This measure includes some ordinary expenditures as well as the more unusual ones for which the model suggests the farmer might borrow.²¹

The production function implicit in the discussion of the first two sections has essentially two inputs: capital, broadly defined, and managerial talent. Farmers with more managerial talent presumably are able to produce greater output with similar capital stocks. It was difficult within the confines of the data to find a suitable measure for a farmer's managerial talents; the annual figure for capital expenditures on farming was selected. Investment, of course, represents an adjustment between an existing and a desired capital stock. Treating this as a measure of managerial talent is based on the presumption that, with wealth and other variables held constant, those who make greater investments have more productive ways to use capital.²²

In testing the model, there was no *a priori* reason to choose among several possible forms, for example, between linearity and log linearity. Of course, experimentation can lead to the discovery of a fit which is in fact spurious; to guard against this possibility, half the observations selected randomly were set aside until a preferred form for the regression was established. The second set of data and the total sample were then used to test how well the chosen model performed on the remainder of the data. The first set of regressions in Table 1 show the results with debt outstanding as the dependent variable. The independent variables included in the model explain about 40 percent of the differences in debt; it is reassuring

²⁰ Included in these expenditures were outlays on such items as death, marriage, and other ceremonies, education, litigation, medicine, clothing, shoes, and bedding.

²¹ Even if the expenditure was anticipated, a farmer might borrow for a ceremony, such as a marriage, if the transactions costs of selling assets were higher than the borrowing costs.

²² Alternatively, greater investments could be made by farmers with the same production possibilities but different tastes for risk or income.

Table 1. Factors affecting agricultural debt in India, 1951-52

Deck	N	Dependent variable	Mean of dependent variable	R ²	Constant term	Interest	Transitory income	Expenditures	Capital outlays	Wealth	Wealth squared
1	336	Debt	376	0.42	156 2.4	- 4.6 - 1.1	-0.19 -1.6	0.44 4.0	0.68 9.7	0.02 3.0	-0.39×10 ⁻⁶ -3.8
2	336	Debt	310	0.42	215 5.7	- 6.7 - 2.7	-0.04 -0.3	0.14 2.7	0.34 5.5	0.03 6.2	-0.16×10 ⁻⁶ -5.7
Total	672	Debt	341	0.39	211 5.9	- 5.9 - 2.6	-0.11 -1.2	0.20 3.7	0.53 11.1	0.02 5.4	-0.14×10 ⁻⁶ -5.2
1	336	Borrowing	227	0.57	20 0.5	- 8.2 - 0.3	0.1 0.1	0.25 3.4	0.74 16.0	0.01 1.9	-0.22×10 ⁻⁶ -3.3
2	336	Borrowing	184	0.50	78 3.2	-18.3 - 1.2	— ^a	0.08 2.4	0.38 9.3	0.02 5.5	-0.10×10 ⁻⁶ -5.5
Total	672	Borrowing	204	0.52	64 2.7	-16.0 - 1.1	0.64 0.6	0.11 3.0	0.59 18.4	0.01 3.8	-0.86×10 ⁻⁷ -4.8

^a F level below 0.01.

to find that the empirical model does as well on the data that had been withheld as on that used in selecting the model. All the coefficients in the first model have the expected sign; most are significant at the 5-percent level. In the second set of regressions, the independent variables are the same but the dependent variable is the amount of borrowing in the year under consideration rather than the amount of outstanding debt. The explained sum of squares rises to 50 percent, but the importance of two of the independent variables, interest rates and transitory income, drops substantially.

The most important variable (in terms of partial correlation coefficients) in explaining the differences in outstanding debt is the amount of investment in farm activities. This association is even stronger in the set of regressions in which borrowing is the dependent variable; the implication of this is that outstanding debts may have been incurred to finance prior investments. Had it been possible to include in the first model not only investment in the present year but in recent past years as well, the correlation between outstanding debt and capital outlays would probably have been even more marked. Even in the relatively stagnant agriculture of India in 1951-52, many of the farmers who borrowed did so to finance capital outlays.

The coefficient of interest rate had the expected sign, but the association was not strong, especially in the set of regressions in which borrowing was the dependent variable. In other regressions, in which the specifications of the model were slightly different, the negative association between debt and interest rates was stronger. The coefficient of the index of transitory income had the appropriate negative sign when debt was the dependent variable, but the level of significance was low. This is explained in part by the fact that the data used had been grouped, a fact which tended to reduce the transitory component of reported income, and in part by the fact that the measure of transitory income is not very good. It is only because the incomes of farmers in an area tend to move together, because all are subject to the same weather conditions, that transitory income shows any association with debt. With ungrouped data, the significance level of this variable would probably have been higher. Again, a higher degree of correlation with debt than with borrowing suggests that, as with the investment variable, there is something of a timing problem with this measure. Farmers probably do tend to borrow more when their incomes are unexpectedly low, though with the existing data this tendency is rather difficult to show empirically.

If all farmers were operating on the same production function, they would desire to hold approximately the same production capital, risk preferences, tastes, and other inputs in the production process held constant. If they held the same stock, then those who owned more would borrow less to buy physical capital. Thus, the expected relationship between debt and

wealth is inverse; yet the results suggest a strong positive association between wealth and debt. The reason probably is that in this model the wealth variable measures size and, as with most industries, the absolute amount of debt increases with the size of the firm.²³ There is a relationship between farm size achieved and farm size sought; large farms grow whereas small farms do not. Desired capital stock was not held constant in these regressions. Thus, there was a positive association between wealth and debt. The relationship was not linear; neither debt nor borrowing increased as rapidly as wealth. In relative terms, the wealthy have less debt than the poor.

There is some instability in the estimates of the coefficients based on the different data sets, though the values of most are within two standard deviations of each other. I do not doubt that there is error in the measurement of the variables and probably some in the specification of the model; the empirical work represents a preliminary attempt to test the model of the first two sections and to quantify the factors associated with agricultural borrowing in a developing country.

In addition to the above work, the relationship between tenancy and debt was examined by fitting another equation, which included as an independent variable the percentage of farmed land owned by the farmer himself. The coefficient had the expected sign; that is to say, other things being equal, debt rose when the proportion of land owned by the farmer increased. In the case of India, the coefficient was not statistically significant. However, in addition to the information in India, data was available on debt among farmers in Thailand.²⁴ In the case of Thailand, too little was known about many of the independent variables to test how well the model explained the differences in debt. But it was possible to undertake an analysis of the relationship between tenancy and debt. The Thai data suggested a significant positive relationship between debt and ownership. Acquiring land by renting is a substitute for borrowing to buy land.

As indicated, for the overall Indian sample, the debts of poorer farmers were higher relative to their wealth than those of richer farmers. But it should be recognized that many small farmers have little or no debt. In India 31 percent of farmers and in Thailand 33 percent had no debts at all. And those with little or no debt were primarily small farmers; for example, the average land holding in Thailand of those with no debt was only 57 percent as large as the holding of those with debts and the average income of debt-free farmers was only 61 percent as great as that of indebted farmers.²⁵

²³ Attempts to introduce other measures of size, such as area sown or gross product, foundered on the problem of multicollinearity.

²⁴ The data on Thailand were gathered in 1962-63 from a sample of 740 Thai farmers [14].

²⁵ Because the data for India are grouped, it is not possible to present comparable figures; but of those classified as small farmers (those whose area farmed fell in the last three deciles of the

It was suggested in the preceding section that the permanently poor are those who are least likely to have good investment opportunities. In India in 1951-52, both the medium- and small-sized farmers as groups were reported to have disinvested; only the larger farmers were adding to their capital stock [1, Vol. 1, p. 800]. Of course, there is diversity within groups. But if small farmers do not have good investment opportunities, then a larger fraction of their debt is likely to be of the unplanned ex post variety. No direct test of this hypothesis was possible, but in India small farmers reported that only 23 percent of their outstanding loans were used to finance investment outlays, whereas 60 percent went to pay for family consumption; for large farmers, the figures were 35 percent for investment and 42 percent for family consumption.

Lack of data made it impossible to test several of the other implications of the theoretical model: Do farmers whose output is more certain²⁶ or who are themselves less averse to risk have more debt? Do those for whom trading assets is more expensive borrow more frequently as a less costly form of adjustment to short-run changes? These and other questions await a more complete analysis of agricultural credit conditions in one or more developing countries.

Implications

In both developed and developing countries, governments have programs for making loans to farmers. The justifications for these are usually that the interest rates charged by private lenders are exploitative and that a lack of capital is both a cause of poverty and a barrier to growth. In another paper [9] I have examined the question of exploitative rates. Here, I only report my findings: in India and Thailand, at least, monopoly in the credit markets exists but is limited. Rates on perhaps 10 to 15 percent of loans are above the competitive level. On other loans, the rates charged the peasants are high, but the yield to the lender is roughly comparable to the returns on capital employed in other ways. The effectiveness of loans to relieve poverty, the second justification for government programs, depends upon the present yield of capital and the elasticity of the marginal product curve. Here I side with Schultz; only in the modernizing sector of a peasant agriculture will extra capital yield a high return. In the traditional sector, development will come only after new information and inputs have made capital more productive. Giving loans to poor farmers at low interest rates will do little to improve their plight unless the loans are accompanied by other inputs which shift their production function.²⁷

size distribution) 85 percent had debts of less than 300 rupees; for large farmers (the top three deciles) only 25 percent had debts of less than that amount [1, Vol. I, p. 75].

²⁶ It is suggestive that in that area of Thailand, the Central Plain, in which weather conditions are most stable, the farmers do have much higher debt-equity ratios.

²⁷ Penny provides strong support for this policy position [11].

Schultz has depicted a traditional agriculture as one in which farmers do not accumulate capital because the good investment opportunities have already been exploited. Farming in India in 1951-52 would, I think, be an example of a traditional agriculture. Yet investment was being undertaken, and the regression analysis suggests that perhaps one-half of the investment expenditures were financed by borrowed funds. Some of the investments were only for replacement purposes and not net additions to capital; but in any case, borrowing to finance such outlays implies a marginal return on capital as great as the costs of borrowed funds; in India at the time, this would have been roughly 12 percent. The amount of investment was small, equivalent to only 4 percent of the existing capital stock of the farmers in the sample. Probably only a relatively few farmers had the kind of opportunities that justified substantial investments financed by borrowing. And if agriculture is viewed as heterogeneous, the fact that some farmers realized yields of 12 percent is not inconsistent with Schultz's overall view that the marginal return to capital in a traditional agriculture is 3 to 5 percent.

T. W. Schultz has provided a very interesting and useful way to look at traditional agricultures. This article has attempted to build on his analysis by showing that within the overall static framework of a traditional agriculture there is considerable diversity among farmers. The life of the individual is not static: it is necessary for the farmer to make frequent adjustments to variations in weather, family circumstances, and market conditions. Moreover, there is in traditional agricultures, such as that of India in 1951-52, a fringe of farmers who find opportunities to expand. In former times, this group comprised merely those who had made the best adjustments to a static agriculture. Today it probably consists of the first farmers to transcend that framework by adopting the techniques of modern farming.

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Potential Effects of U.S. Commodity Grants to Other Countries

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Different types of local currency have been generated by U.S. commodity grants since the inception of P.L. 480 in 1954. As an aid instrument, these local currencies have good points, but they also have serious deficiencies which can be traced to the inherent nature of soft currencies and their legal ownership. The differing economic effects of U.S.-owned and country-owned local currencies became significant when P.L. 480 became a major source of U.S.-owned local currencies. Before 1954, about 95 percent of local currency deposits were country-owned; since then, 66 percent of these deposits have been U.S.-owned. The monetary and real effects of these two types of local currency are examined, as are the implications for U.S. aid policy.

LITTLE systematic analysis has been undertaken of the effects of U.S. financial assistance in the form of commodity grants programs. As a result, there have been misconceptions about the value of foreign currencies (primarily generated by commodity assistance) to the overall U.S. assistance program. One area of confusion has been the failure to distinguish between U.S.-owned and country-owned local currencies.

Except for the work of Asher [3], who in 1961 briefly examined the political, legal, and economic differences between these two types of local currency, there has been no consideration of these differences. The changes that have occurred in local currency policy and procedures in the past few years, as well as congressional pressure on the Agency for International Development (A.I.D.) and other U.S. agencies to make greater use of local currencies, have made discussion of the economic differences (real and monetary) between U.S.-owned and country-owned funds essential.

Definitions

Country-owned and U.S.-owned local currencies have been commonly referred to, respectively, as *counterpart funds* and *United States Disbursing Officer's (U.S.D.O.) funds*. Originally, these terms applied only to commodity assistance grants (Table 1). But in recent years, they have been applied also to local currencies resulting from non-grant (commodity and dollar) assistance, miscellaneous sales programs, and contributions by recipient countries for U.S. advisory assistance (Table 1). These local currencies will be referred to as *contributing counterpart* or *contributing U.S.D.O. funds*, depending on their legal ownership. Generally, the allocation and disbursement of the various local currencies require the joint

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Table 1. Summary of U.S.-owned and country-owned local currency deposits, fiscal years 1955-1967 (in million-dollar equivalents)

Fiscal year	Country-owned				U.S.-owned					Grand total
	Grants ^a	Special letter of credit ^b	Trust funds	Total	P.L. 480 Title I	MSA 1954 Section 402 (country-use)	Loan repayments ^c	Others ^d	Total	
1955	808.6	—	8.7	817.3	57.3	113.5	—	379.9	550.7	1,368.0
1956	805.7	—	9.3	815.0	343.2	305.0	—	232.0	880.2	1,695.2
1957	797.0	—	9.1	806.1	1,011.1	436.0	—	179.8	1,626.8	2,432.9
1958	799.8	—	15.0	814.8	686.1	290.4	—	209.2	1,185.7	2,000.5
1959	607.9	—	13.9	621.8	836.9	219.8	7.0	206.5	1,270.2	1,892.0
1960	626.6	—	20.6	647.2	865.5	170.6	19.0	155.6	1,210.7	1,857.9
1961	650.3	—	24.4	674.7	990.6	160.6	52.8	99.1	1,303.1	1,977.8
1962	597.7	—	24.7	622.4	985.1	117.0	99.3	85.3	1,286.7	1,909.1
1963	546.9	36.2	40.0	623.1	1,182.6	13.1	162.7	165.9	1,544.6	2,147.4
1964	366.2	56.4	43.6	466.2	1,106.7	-0.4	191.8	139.5	1,450.2	1,903.8
1965	264.0	181.9	45.2	491.1	1,172.7	0.4	226.2	198.4	1,614.0	2,088.8
1966	338.3	242.3	63.4	644.0	929.6	1.7	251.9	199.2	1,400.7	2,026.4
1967	412.4	166.1	104.5	683.0	762.5	1.0	294.1	226.4	1,316.2	1,967.0
Total	7,011.4	661.9	442.4	8,115.7	10,929.9 ^e	1,828.7 ^f	1,304.8	2,476.8 ^g	16,639.8	25,466.8

^a Includes funds generated by Defense Support, Special Assistance, Supporting Assistance, P.L. 480, Title II, GARIOA, Coal Procurement Fund, Development Grants/Technical Cooperation, and Contingency Funds.

^b Includes Development Loans for program assistance and Supporting Assistance Loans.

^c Includes P.L. 480 Title I, D.L.F., Basic Materials-Mining Facilities Programs, M.S.A., E.C.A., and others. Deposits are understated because of the lag in reporting by the U.S.D.O. to the U.S. Treasury.

^d Includes Lend-Lease and Surplus Properties, Interest on Depositary Balances, Military Assistance programs, Sales of Buildings, Special Letter of Credit for project assistance, 5- and 10-percent Counterpart, and others. S.L.C. deposits were \$428.7 million.

^e Local currencies generated by commodity assistance grants. "Others" includes 5- and 10-percent Counterpart, which amounted to \$158.5 million, and part of the S.L.C. account, which amounted to \$63.7 million.

^f Does not include P.L. 480 Title IV nor Development Loans under standard commodity procedures. Between fiscal years 1961 and 1967, P.L. 480 credit sales amounted to \$886.7 million. A.I.D./Washington has not required reporting on these local currencies.

^g Annual deposits are adjusted for principal repayments made in local currency and dollars. As of June 30, 1967, principal repayments amounted to \$99.7 million.

Sources: Compiled from data made available by U.S. Treasury, Fiscal Service, Bureau of Accounts, and U.S. Department of State, A.I.D., Office of the Controller.

approval of the United States and the cooperating governments. In a few cases, the United States has no control over or influence on the allocation and disbursement of the local currencies,¹ but these cases are not discussed in this article.

Unlike country-owned funds, which are reserved solely for country program activities, U.S.-owned funds are reserved for U.S. uses and/or country program activities, depending on their source.² Where the supply of nonrestricted currency reserved for U.S. uses substantially exceeds normal U.S. needs for the next two or three years, the U.S. Treasury has, since fiscal year 1961, designated the currency "excess." As of June 30, 1967, there were \$1.38 billion available for U.S. uses in the "excess" countries [12]. Since fiscal year 1965, the U.S. Treasury has designated certain currencies "near-excess" where the supply of the currency is somewhat above immediate U.S. needs.³ As of June 30, 1967, there were only \$7 million available for U.S. uses in the near-excess countries [12]. The currencies of the other countries are called "non-excess," since nonrestricted U.S. holdings are not expected to exceed U.S. requirements in the foreseeable future.

The significance of the "excess currency" or "near-excess currency" designation is that it permits U.S. government agencies to finance overseas activities without the loss of regular dollar appropriations. Separate or supplemental appropriations are made by Congress as either a special foreign currency program appropriation or a foreign currency expenditure authorization.⁴ However, "near-excess" requests are not looked upon fa-

¹ These local currencies result mainly from development loans financed by standard commodity procedures (letters of commitment), such as pre-1967 P.L. 480 dollar credit sales under Title IV arrangements, two-step loans (explained in footnote 5), and that part of the sales receipts obtained by recipient governments which was not required to be deposited.

² Only under P.L. 480 Title I local currency sales have deposits been set aside for both U.S. uses and country program uses. Under Sections 550 and 402 (agricultural surplus disposal programs under the Mutual Security program) deposits were set aside mainly for country uses. Other U.S.-owned funds have been set aside for U.S. uses only. Estimates of such funds are given in Table 1. U.S.-use funds have been primarily expended for embassy operations, military obligations, defense housing, overseas expenses of U.S. agencies, public health services, and education [11]. Country-use funds have been expended for development activities, including loans to private enterprise, and for military support programs (common defense). Country-owned funds have been used for similar activities but chiefly for military support programs.

³ As of June 30, 1967, Burma, Ceylon, the Congo (Kinshasa), Guinea, India, Israel, Pakistan, Poland, Tunisia, United Arab Republic, and Yugoslavia were designated as excess countries for fiscal year 1968, and Bolivia, Indonesia, Morocco, Ghana, and Sudan as near-excess countries. The Congo was removed from the list in December 1967.

⁴ Special foreign currency programs finance lower priority activities than those financed through regular appropriations. Congress provides additional dollar appropriations for local currency requests. The use of these funds results in an expenditure

vorably by the Bureau of the Budget, which must approve U.S. agency requests. As explained later, the real and monetary effects of "near-excess" and "non-excess" currencies are similar.

Magnitude of Local Currency Programs

Before the passage of P.L. 480, about \$13.2 billion of local currencies were generated by U.S. economic and military assistance programs and miscellaneous transactions, 95 percent of which were country-owned [11]. With growing anti-grant feelings in Congress in the mid-1950's, it became politically more acceptable to require that future local currencies be U.S.-owned. Exceptions to this shift in legal ownership were defense support and special assistance where the United States had large military commitments or where political instability dictated minimum U.S. involvement in domestic affairs. This policy has continued for supporting assistance and, at times, for contingency funds since the Foreign Assistance Act has been in effect.

The shift in ownership of local currencies began with the passage of Section 550 of the Mutual Security Act of 1953 and culminated with the passage of P.L. 480 in July 1954. Since the passage of P.L. 480, some \$25.3 billion of local currencies have been generated (Table 1), with 66 percent of these funds U.S.-owned, mainly as the result of P.L. 480 Title I sales. Of these local currency deposits, \$20.6 billion have been the result of commodity assistance grants, 63 percent of which were U.S.D.O. funds, mainly Title I and Section 402. But the grant component of U.S.D.O. funds must be reduced by the amount of Title I loan repayments and local currency reserved for U.S. uses which replaced U.S. purchases of local currency. This point is discussed in the following two sections.

In the future, it can be expected that Title I and Development Loan Fund (D.L.F.) repayments will become more important sources of U.S.-owned funds. By the end of 1971, P.L. 480 sales for local currency (U.S.D.O. deposits) will be allowed only to the extent that local currencies are needed for U.S. uses, common defense, loans to private enterprise, and family planning and related activities. With the shift in P.L. 480 from local currency sales to sales on credit repayable in dollars, contributing counterpart funds will become a more important means to

being reported for the using agency and a receipt for the Commodity Credit Corporation (for P.L. 480 funds used) or another agency which originally acquired the local currency, usually the Treasury. Major U. S. departments making use of these funds are the Library of Congress, Agriculture, Defense, State, and Health, Education and Welfare. Foreign currency expenditure authorizations do not result in loss of dollar appropriations, for these authorizations are made in local currency. Major activities carried out are emergency relief, defense housing, assistance to third countries, and American schools and hospitals abroad. In both types of separate or supplemental appropriations [8, 10] Congress can direct U.S. agencies to carry out specific activities.

finance agreed-upon country program activities. Local costs of country program activities will also depend to a larger extent on trust funds and development loans using the special letter of credit mechanism (S.L.C.).⁵

The future shift in local currency ownership may solve the persistent problem of programmed expenditures lagging behind deposits. At the end of fiscal year 1967, there were \$2.4 billion of unexpended balances, 91 percent of which were U.S.-owned, with 37 percent of these unexpended U.S.-owned balances in India [14]. The small percentage of unexpanded country-owned deposits can be traced to A.I.D.'s leverage effect of including local currency uses in the original dollar agreement. In addition, recipient governments have been more willing to cooperate on the use of country-owned funds because of their legal ownership and availability on a grant basis (that is, no future repayment obligation to the United States).

The accumulation of U.S.-owned funds is the result of two factors. First, recipient countries have resisted U.S. involvement in their monetary and fiscal affairs, especially when the United States has attempted to lend the countries their own currencies for country program activities. But most of the funds have been obligated (formal commitment of funds) for country program uses and will be disbursed in the next few years for agreed-upon projects. The serious problem here is the lack of parallel programming (disbursements do not occur at about the same time as commodity imports) and the eventual inflationary pressures resulting from local currency expenditures. This point is discussed later. Second, statutory provisions have required local currency deposits in U.S.-use accounts without regard to U.S. needs. The Mondale Amendment to the 1936 Food for Peace Act provides a partial solution to this excess problem, for it permits grants of excess P.L. 480 funds for country development activities. However, in certain excess countries such as India, Pakistan, and Yugoslavia, about 45 percent of idle balances of U.S.-use funds can be attributed to D.L.F. loan repayments [14]. In the future, the excess situations will be partially solved by the transition of P.L. 480 to credit sales and possibly a more liberal policy with regard to the use of D.L.F. repayments, which presently require dollars appropriations.

⁵ The S.L.C. is a method of commodity financing used when an immediate generation of local currency is needed for project (U.S.-owned local currency) or program (country-owned local currency) assistance. Under this method, local currency is available for disbursement before commodity arrivals and distribution. Under standard commodity procedures, counterpart funds are deposited after commodity arrivals and distribution. Trust funds are country-owned funds made available by recipient governments to the United States for local costs of advisory assistance or travel. A potentially large source of country-owned funds is two-step loans. These loans generate local currency equal to the differential interest rate paid by private firms (recipient of the original dollar loan) to the recipient government and that paid by the recipient government to the United States.

Economic Differences

Local currencies generated by U.S. assistance programs have little in common with dollars or other freely convertible currencies, since they can neither command additional imports nor substitute perfectly for convertible currencies. In addition, there are potential economic differences between country-owned and U.S.-owned local currencies generated by U.S. grant assistance, which are the major focus of this article.⁶

Economic differences between counterpart and U.S.D.O. funds are contingent on an individual country's monetary and fiscal policies, bilateral agreement provisions, financial procedures of different U.S. grant programs, and the distinction in U.S.D.O. holdings between U.S. uses and country programs uses. Four major economic differences have emerged because of these factors. Counterpart funds do not benefit the U.S. *balance of payments* since they are not reserved for U.S. uses. Only U.S.D.O. loans may result in a loss of real resources from the viewpoint of the recipient countries because of their effect upon recipient countries' *debt obligations* to the United States. *Time-limit provisions* concerning reallocation of local currencies apply only to U.S.D.O. funds. *Deposit requirements*, at times, differ for these two types of local currencies. Each of these differences is discussed in turn.

Balance-of-payments benefit from use of local currencies

Many U.S. government agencies and nonprofit organizations are engaged in overseas activities which result in payments in foreign currencies. From various assistance programs, particularly P.L. 480, the United States has acquired foreign currencies to finance these overseas activities without spending dollars. The balance-of-payments benefit derived from U.S.-owned local currencies depends on what U.S. purchases would have been in the absence of these funds.

In the regular appropriations process, it is impossible to estimate accurately the portion of these expenditures that would have occurred in the absence of U.S.-owned local currencies. It depends on U.S. priorities and objectives in individual countries. The U.S. Treasury has estimated that \$3.7 billion of regular appropriations between fiscal years 1955 and 1967 have been financed by local currencies, \$1.4 billion from Title I.⁷ A.I.D.

⁶ Empirical evidence of these economic differences is largely from the country studies conducted under university contract by the U.S. Department of Agriculture on Colombia, Israel, Turkey, Greece, and India [1, 2, 4, 6, 7], and a local currency study on Spain which I made under a grant from the Agricultural Development Council in 1966 [5].

⁷ Data were obtained from the U.S. Treasury, Fiscal Service, Bureau of Accounts. This information may also be found in the P.L. 480 Annual Report [10]. Treasury estimates of regular appropriations in the P.L. 480 Annual Report include S.L.C. for project assistance.

has taken the position that project assistance financed by the S.L.C. mechanism should be included in dollar savings. By providing assistance tied to commodity purchases in the United States for the local currency obtained, A.I.D. claims, it mitigates unfavorable consequences for the U.S. balance of payments. However, there are no additional dollar savings if the commodity assistance is part of the country's annual assistance program. The S.L.C. is only a means of preventing delay in local currency deposits and disbursements for high-priority projects. For contingency funds which are unplanned additional country program assistance, the use of the S.L.C. mechanism might reduce the dollar outflow. Dollar savings would depend on whether local currency could have been obtained from other sources such as unexpended country-use funds or the recipient government's budgetary transfers. Secondary consideration has been given by A.I.D. to this alternative. In most cases, A.I.D. has, for political reasons, not pressured recipient governments into reallocating budgetary expenditures. Overall, the S.L.C. for project assistance has not resulted in appreciable balance-of-payments savings.

Most of the local currency expenditures under separate appropriations have not resulted in balance-of-payments savings. Before fiscal year 1961, there was no budgetary control over local currency uses. In many cases, U.S. agencies used local currencies for low-priority uses where U.S. Treasury holdings were not sufficient to meet normal U.S. requirements. Because of growing U.S. balance-of-payments problems and dollar losses caused by the uncontrolled use of local currencies, Congress directed, in 1961, that separate appropriations could be made only in excess currencies. It was also hoped that, by restricting separate appropriations to excess currencies, embarrassingly large accumulations of certain currencies would be reduced.

Under foreign currency authorizations (no charge to dollar appropriations), \$204.7 million has been expended, \$118.4 million before fiscal year 1961 [8, 9, 10]. With tighter budgetary controls, most of these expenditures would not have occurred in non-excess countries. In the post-1961 period, the use of excess currencies has in many instances been related more to political motives than to economic priorities. Balance-of-payments savings, however, have resulted from certain third-country purchases with Title I funds. For example, dollar savings can be attributed to the use of Indian rupees to defray U.S. expenses in Nepal, which have amounted to \$48.4 million [14].

Under special foreign currency programs (charged to dollar appropriations but lower-priority activities than regular appropriations), \$268 million of local currencies have been expended since initiation of these special programs in 1961 [10, 14]. Generally, Congress has provided additional dollar appropriations for local currency purchases, but in the ab-

sence of excess currencies, certain activities would have been financed by regular appropriations. These include agricultural research services, expenses of the U.S. Information Agency, and State Department building activities. The balance-of-payments benefit derived from financing these activities with excess currencies has been about \$75 million [14]. About \$70 million of these expenditures were financed by Title I.⁸

Briefly, the contribution of U.S.-owned local currencies to the U.S. balance of payments between fiscal years 1955 and 1967 under these regular and separate appropriations has amounted to \$3.8 billion. Title I has accounted for \$1.5 billion of this dollar savings, which was about 18 percent of Title I disbursements for U.S. uses and country program uses [10, 14]. With the shift in P.L. 480 to credit sales, potential dollar savings will result mainly from Title I loan repayments rather than local currencies reserved for U.S. uses in the original sales agreements. Dollar savings from U.S.-owned local currencies could have been greater, as shown below.

Not included in this estimate is P.L. 480 local currency budgetary support for military operations (common defense) which has amounted to \$1.2 billion [12]. Not all of these expenditures would have occurred in the absence of P.L. 480. This would depend on whether A.I.D. would have reduced development loan and technical cooperation appropriations in order to increase defense support and supporting assistance grants. The effect of this substitution on the balance of payments is difficult to estimate. It depends on the percentage of dollar assistance spent for off-shore procurements (assistance not tied to purchase in the United States) and the amount of these expenditures which returns indirectly to the United States.

The potential balance-of-payments benefit derived from P.L. 480 in non-excess countries would have been larger if there had not been differential interest rates on Title I loan agreements signed between 1957 and 1962. Under differential interest arrangements, recipient governments have been allowed to repay their Title I local currency loans at 4 or 5 percent in local currency or 3 or 4 percent in dollars. Originally, the United States formulated such a policy hoping to obtain a dollar return where it expected U.S. needs to continue to be less than local currency availabilities. The opposite occurred. As of June 30, 1967, 11 non-excess countries had taken advantage of this option, denying the United States about \$5 million in dollar savings [13].

Another possible source of dollar savings would have been the continuance of the maintenance-of-value clauses (M.O.V.) in Title I loan agree-

⁸ For special appropriations, the U.S. Treasury has given first priority to the Title I account, relying only on D.L.F. repayments and the miscellaneous accounts as the supply of Title I funds has become low. In the past few years, the Treasury has been drawing on non-P.L. 480 accounts in Pakistan, Israel, and Yugoslavia.

ments after April 1959. Overall, the United States has suffered a loss in value of foreign currency holdings equivalent to \$785 million, 53 percent of which has been in Brazil, India, the United Arab Republic, and Yugoslavia [13]. In addition, the General Accounting Office, the Bureau of the Budget, and A.I.D.'s Office of the Controller have supported the imposition of M.O.V. provisions on U.S.-use funds. They point out that, because of devaluation, the United States lost about \$595 million of potential dollar savings between fiscal years 1955 and 1967 [14]. This overstates the real dollar loss, since 67 percent of it has occurred in the "permanent" excess countries (that is, those which have been on the excess list since its beginning in 1961 and in which local currency availabilities beforehand exceeded U.S. needs: India, Israel, Pakistan, Yugoslavia, and the United Arab Republic). Actually, M.O.V. requirements are contradictory to the original purpose of grant assistance, which was to relieve recipient countries of external debt obligations so as not to jeopardize further their development efforts.

An indirect balance-of-payments effect has been the additional import demand generated by the expenditure of U.S.-use funds. When these expenditures have been used for military operations, the United States has usually provided additional economic assistance in the form of defense support, supporting assistance, or, occasionally, additional P.L. 480 grants, to offset the foreign exchange component of this demand.⁹ In other cases, A.I.D. has not provided additional balance-of-payments support to offset the indirect foreign exchange cost of local currency spending.

The balance-of-payments benefit derived from U.S.-owned local currencies has resulted largely from reserved U.S.-use funds under Title I sales agreements and miscellaneous sales programs. In many countries, Title I and D.L.F. loan repayments are now the major sources of dollar savings. Where these repayments are not sufficient to meet U.S. needs, A.I.D. has been supporting a more gradual shift in P.L. 480 to credit sales. The following section is concerned with the dollar savings which the United States has obtained from local currency loan repayments and their impact on the debt position of recipient countries.

Debt obligations

Of growing importance in defraying U.S. overseas expenses are loan repayments under U.S.D.O. programs. There is no outflow of foreign exchange from the borrower unless A.I.D. local currency loans are repaid in dollars or until these local currencies become convertible. Where A.I.D.

⁹ In Spain, Turkey, and Greece, part of the U.S. assistance provided to offset local military expenditures was Section 402 grants. Only in Spain was this effect analyzed [5, pp. 27-34]. In both Korea and Vietnam, additional P.L. 480 has been provided to offset military expenditures.

loans are repaid in local currency, recipient countries suffer dollar losses equivalent to that part of local U.S. expenses that would have occurred in the absence of these repayments.

At the end of fiscal year 1967, loan repayments in local currency totalled \$1.3 billion and repayments in dollars under the option provision totalled \$92.7 million [13]. D.L.F. and Title I, the major sources of local currency repayments, accounted for 42 and 37 percent, respectively, of these repayments. At present, the United States has outstanding loans of \$5.2 billion (adjusted for exchange-rate losses) repayable in local currencies, with \$401 million of the balance outstanding expected to be repaid in dollars [13]. Title I and D.L.F. repayments will amount to \$3.3 billion and \$1.6 billion, respectively. About \$292 million or 8 percent of Title I loans outstanding can be expected to be repaid in dollars. About \$2.4 billion of the Title I principal outstanding will be repaid in local currency by the present excess countries, excluding Poland, which is repaying Title I loans in dollars. Also, Israel has reborrowed, in some cases, local currency repayments and will repay these partly in dollars.

In its published and unpublished analyses of the external indebtedness of member governments, the World Bank does not include loans repayable in local currency. If Title I loan repayments (local currency and dollars under the option clause) were included in the World Bank's definition of external debt, these repayments would be a relatively important part of the external debt position of several countries between fiscal years 1968 and 1976. The ratio of Title I payments, including interest collections, to external debt payments in major Title I recipients during this period is as follows: 60 percent in the United Arab Republic, 35 percent in Israel, 24 percent in Turkey, and about 13 percent in Morocco, India, Colombia, Spain, and Pakistan.¹⁰ Except in India, Pakistan, and the United Arab Republic, Title I loan repayments will reduce significantly the dollars earnings of the recipient countries mentioned above. In the case of Israel, the rapid reduction in U.S. holdings of local currency because of the Middle East crisis will probably result in Israel's being removed from the excess list in 1969.

Internally, Title I loan repayments require recipient governments to reduce their domestic savings to make available the local currency required for U.S. uses. This additional internal claim on local resources could be offset by an increase in capital accumulation, by a continual growth in per capita production, and/or by the social benefits or revenues made possible by the original Title I investments.¹¹

¹⁰ External indebtedness data were obtained from the Statistics and Report Division of the International Bank for Reconstruction and Development. Information on Title I loan repayments was obtained from A.I.D., Office of the Controller.

¹¹ The estimate of the contribution of local currency to national product is based on four assumptions: first, that these funds are similar to taxes or real savings, with

A small part, 4 percent, of the future debt obligations have been created by Title I Cooley loans.¹² The major effects of the Cooley loans have been to reduce imports, to expand domestic consumption, and, to a smaller extent, to increase export earnings. Because of fragmentary data, it is difficult to estimate the net flow of resources of recipient countries and to determine whether Cooley investments will offset the future debt obligations created by the original loans. This partly depends on the portion of these investments which would have occurred in the absence of these funds.¹³

In the case of counterpart funds, recipient countries at no time surrender real resources to the United States. Like Title I local currency loans, however, they increase recipient governments' obligations (within their budgets or as extra-budgetary obligations) to use these funds for agreed-upon purposes. Also, Title I and other U.S.D.O. grants, specifically those under Section 402, are similar to counterpart funds in that no future external debt obligations are incurred.

Briefly, in certain countries local currency loan repayments are a significant part of their external public debt obligations, but only in the non-excess countries are these repayments the major source of dollar savings. In the countries now listed as "excess," local currency loan repayments will be the major source of dollar savings by the end of fiscal year 1969, except in India and the United Arab Republic.

Time-limit provision

The importance of the time-limit provision as an economic difference is contingent on two interrelated variables which result specifically from P.L. 480 local currency sales and loan agreements. The sales agreement specifies that within three years, agreement must be reached on the use of local currency for country program uses. However, it is the loan agreement, which is signed separately, that lists the various uses and repay-

their expenditure occurring at the time of commodity imports; second, that there are underutilized or unutilized domestic resources and that additional U.S. assistance is available to offset the indirect foreign exchange component of these local currency expenditures; third, that these funds are transferred from less productive uses; and fourth, that concessional imports are diversionary, thus allowing an increase in net expenditures. The fourth assumption implies that the increase in foreign exchange reserves is not offset by the import demand generated by local currency spending. This macro-framework is explained in Deans [5] and Ginor [6].

¹² P.L. 480 has for a number of years authorized a certain portion of local currency deposits for Cooley loans. These are loans to U.S. business firms, affiliates, or subsidiaries to promote development or to establish facilities that will increase markets for U.S. agricultural products.

¹³ Cooley loans in Israel [6, pp. 307-351], Colombia [1, pp. 157-161], Turkey [2, pp. 333-352], and Greece [4, pp. 175-186] have been small in number and relative volume and, in most cases, would have occurred in the absence of Title I funds. The projects were capital-intensive and they increased import demand in the recipient countries. Their contribution to capital formation, if any, was marginal and not decisive.

ment terms. The failure to advance Cooley funds or to obligate Section 104(f) funds within three years after the signing of the sales agreement may result in the transfer of these funds to other uses, including U.S. uses.¹⁴ This provision induces recipient countries to advance or obligate these funds to avoid their reallocation and future loss of dollar earnings.

The reallocation of Title I funds has not been large. As of June 30, 1967, according to U.S. Treasury reports, only \$202 million had been reallocated, with \$165 million being transferred from country to U.S. uses [15]. By the end of fiscal year 1967, the reallocation of Title I funds from country to U.S. uses in near- and non-excess countries had provided the United States with an additional \$113 million in balance-of-payments benefits.

The most important source of the \$202 million reallocation has been Cooley loan funds, which have accounted for \$153 million of the transfer. The major reasons for the failure to advance Cooley loans to a borrower within the specified period have been the failure of A.I.D. and the host government to reach mutual agreement on individual loans, the restrictions placed on U.S. investment by the host government, and the lack of profitable opportunities. The small amount reallocated under Section 104(f) loans can be traced to the obligation mechanism and, at times, to the lack of strict enforcement of this provision. Under the obligation requirement, recipient governments have been obligated only to carry out the agreed-upon project or program, with actual expenditures occurring at an unspecified future date. Because of the lack of parallel programming, most recipient governments have manipulated the original deposits for their own use.¹⁵ Eventually, the formal disbursement of these funds re-

¹⁴Section 104(f) funds are used to promote multilateral trade and agricultural and other economic development on a loan or grant basis. In the pre-1967 period, grants and loans for development occurred under Sections 104(e) and (g), respectively. In the new P.L. 480 legislation, funds are used under Section 104(h) for nutrition and family planning activities on a grant basis. In previous P.L. 480 legislation these activities occurred under Section 104(g) on a loan basis, and under Title II, Section 202 (grants for economic development) as a counterpart program. Since Section 104(h) has been part of Title I legislation only since 1967, time-limit provisions and their effects are not yet important.

¹⁵ Because of both the delay in signing Title I loan agreements and the limitations on the absorption of Title I funds into agreed-upon projects, there was a lag in the formal disbursement of these funds for country program uses, except in Israel [6, p. 15]. Since policy objectives in Turkey [2, pp. 521-525], India [7, pp. 6-30], and Greece [4, pp. 153-159 and 162-173] were opposed to letting these funds remain idle, the governments of these countries printed special securities or money to substitute for these idle balances in the central bank. In Spain [5, pp. 43-60] no evidence was found that the government had used U.S.D.O. funds before their formal disbursement. It is entirely possible that the government carried out additional budgetary expenditures using these funds as reserves. It is impossible to estimate accurately their contribution to gross capital formation because of their fungibility (inability to designate the projects actually financed) and the money illusion which surrounds their use.

sulted either in a budgetary transfer (reduction in other expenditures) or, the more common practice, inflationary financing of the agreed-upon projects. Exceptions to this lack of parallel programming have been in Korea and Vietnam, where U.S.D.O. grants have been disbursed mainly for military support activities.

The time-limit provision may have induced recipient governments to agree to lower-priority projects. At times, these projects may have generated an additional import demand which would not have occurred if there had been no Title I funds or if recipient governments had been allowed to use these funds for other purposes.¹⁶ It is difficult to distinguish the effects of the time-limit provision from other types of pressure that A.I.D. might have used to induce the undertaking of specific projects.

Unlike P.L. 480, counterpart funds have had no time limit placed on their repayment nor has the United States exerted undue pressure (curtailment or reduction in economic assistance) for disbursement of these funds once they have been obligated or committed to agreed-upon uses. Since the Foreign Assistance Act has been in effect, counterpart funds have been earmarked mainly for military support programs or for budgetary support to promote political stability. In most countries these funds have been disbursed at about the same time that commodity imports have been distributed. As a result, there has been no manipulation of these funds and no consequent inflationary effects resulting from a delay in their spending.

During the Mutual Security period, defense support programs which generated counterpart funds were similar in their monetary effects to Title I and other U.S.D.O. programs (Section 402). Generally, these funds were reserved for programs and projects which were not completed in the same period as commodity imports and distribution. Recipient governments' manipulation of these balances for other uses resulted in additional inflationary pressures at the time of their formal disbursement.

The significance of the economic differences between U.S.D.O. and counterpart funds can be attributed primarily to monetary effects and secondarily to real effects. The original goal of the time-limit provisions, to encourage parallel programming, has not been attained for many reasons. First and most important has been the friction resulting from U.S. attempts to lend recipient countries their own currencies. Second, the United States has made no attempt at the time of P.L. 480 sales agreements to reach agreement on the integration of local currency uses into continuing projects at the time of commodity assistance imports and dis-

¹⁶ In Spain [5, pp. 56-60 and 68-69], Israel [6, pp. 48-52 and 57-59], Colombia [1, pp. 162-166], and Greece [4, pp. 243-260], lower-priority projects were carried out that would not have occurred in the absence of Title I. Only the Spanish and Israeli reports examined the additional import demand generated by Title I investments. The import components of these investments were about 3 percent and 16 percent, respectively.

tribution. As more countries are required to sign credit sales agreements, the time-limit provision will become less relevant. Finally, the reallocation of Title I local currencies has been quite small. Most countries have obligated these funds within the time limit without seriously considering their disbursement until later.

Deposit requirements

From the inception of U.S. assistance, local currency deposits have been required when commodities or services have been provided on a grant basis and, at times, when sales receipts have resulted from commodity assistance loans. For the most part, deposit requirements have been the result of erroneous beliefs of congressmen and certain A.I.D. officials that these funds provide the United States with additional influence or control over recipient governments' budgetary decisions and that their formal disbursement contributes to development. These conditions may be true in limited cases, as mentioned earlier; otherwise, there is no justification for requiring local currency deposits.

Since 1965, the legislation has required that the conversion rate used to compute deposit requirements (that is, the local currency value of dollars disbursed) not be less favorable to the United States than the highest exchange rates which are obtainable by any other nation. Before 1965, the exchange rates used were less favorable than those obtained for commercial purchases. At times, the United States has also required that the import charges on U.S. commodity assistance be deposited. This has depended on the type of assistance, the method of financing, legislative directives, and the loan or grant basis of assistance.¹⁷ Overall, sales receipts from the domestic sale of commodity assistance have exceeded deposit requirements. Beginning in 1965, however, recipient governments have obtained additional revenue mainly when import taxes have not been part of deposit requirements.

In certain instances, deposit requirements under P.L. 480 local currency sales have exceeded sales receipts.¹⁸ The recipient government, acting as

¹⁷ Under A.I.D. commodity programs as well as P.L. 480, local currency deposits must not be less than the local currency value of dollars disbursed by the United States. Under letters of commitment, import charges are deposited for A.I.D. commodity assistance grants and P.L. 480 credit sales. For P.L. 480 local currency sales, import charges are deposited only where there exists a multiple exchange system. Under S.L.C. procedures, deposits do not include import charges for A.I.D. commodity assistance loans or grants. From the legal standpoint, Congress has directed that, for supporting assistance grants, deposits must at all times include import charges. This inconsistency in deposit requirements has never been supported by economic reasoning.

¹⁸ The governments of Brazil, Chile, India, Paraguay, the Ivory Coast, and Senegal have subsidized Title I grain imports. In India as of March 1962 [7, pp. 13 and 121-138], the government had spent Rs. 525.7 millions in subsidizing P.L. 480 foodgrains. Excluding funds reserved for U.S. uses, the amount of local currency

the importer, has received less than the alternate value of its resources unless some of the deposits have been granted or the agricultural assistance had a higher value to the recipient country than the alternate uses of the domestic monetary resources needed to finance these imports. In the latter case, deposit requirements would exceed sales receipts if the country's development was being limited by the shortage of food or if the availability of P.L. 480 assistance allowed the recipient country to divert foreign exchange from food imports to investment goods. To subsidize Title I imports, the recipient government has had three alternatives. First, it could divert budgetary resources, including country-owned local deposits, from other uses. Second, it could print money or increase its borrowing from the banking system, with consequent inflationary effects. Finally, it could obtain the additional funds by increasing general or specific tax rates. Only the first two alternatives have been used.¹⁹ Consequently, the recipient government has been burdened by the additional payments made necessary by Title I imports. In addition, the local economy has experienced the inflationary effects of the government's financing these imports if the local currency was not granted to the recipient government.

Concluding Remarks

The U.S. rationale for requiring local currency generation, mainly for grant assistance, has been to achieve some control over local development activities and to defray U.S. overseas expenses, primarily military. Where the U.S. has had large military commitments, A.I.D. has minimized its involvement in development decisions to avoid the political friction which accompanies Title I local currency loan negotiations. In other countries, U.S. influence has depended on the degree of agreement or divergence between A.I.D. and recipient government development priorities and the initiative of the A.I.D. mission.

The economic significance of U.S.D.O. and counterpart funds has not been contingent on the inherent nature of soft currencies alone. It has also depended on the real and monetary effects of these currencies in recipient countries. The importance of the real effects has depended on the ability of the United States to substitute U.S.-owned local currencies for overseas expenses, mainly from reserved U.S. uses in Title I sales agreements and Title I and D.L.F. loan repayments. Counterpart funds have provided no balance-of-payments savings to the United States nor have they created any additional debt obligations for recipient governments.

reserved for investment purposes was reduced by 10 percent, Title I imports being assumed additional.

¹⁹ Only in India and Brazil, of the countries investigated, were local currency grants made at the time of imports. As a result, the additional costs incurred to finance Title I imports were not reduced. In the West African countries and possibly in Chile, the first alternative was used. The second alternative was used in the remaining countries.

The monetary differences could be attributed to the inflationary effects resulting from a lack of parallel programming under P.L. 480 and from the need, at times, for recipient governments to subsidize Title I imports. The real effects of the economic differences between these two types of local currency are more important. But the importance of monetary differences cannot be ignored, especially if these funds have caused a reallocation of budgetary resources and a change in development priorities.

In the next few years, contributing counterpart funds will become the major source of local currency generation as commodity assistance programs continue to shift from grants to loans. The implications of this shift are still unclear, particularly in respect to the special letter of credit, the transitional terms of P.L. 480, and the impact on the international accounts of the United States and recipient countries.

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The Use of a Business Game for Teaching Farm Business Analysis to High School and Adult Students*

SAMUEL M. CURTIS

In a controlled teaching experiment that involved 25 high school and 8 adult farmer classes, two ways of using a business game for teaching farm business analysis were compared with more traditional instructional methods. A small Pennsylvania dairy farm was simulated. Each of the classes using simulation made five yearly management decisions at weekly intervals. The criterion measures were a subject-matter and a decision-ability test. Test results immediately after the course revealed no significant differences among the methods of instruction with high school classes. The adult students who used the simulation in conjunction with a related student resource handbook scored significantly higher on the decision-ability test. The experiment demonstrated that business games can be used to teach farm business analysis at the high school and adult farmer levels.

THE purpose of this study was to evaluate the effectiveness of a business simulation model for teaching farm business analysis and records keeping to high school and adult students. The farm business simulator used in the study¹ was designed to help students learn economic principles by manipulation of the simulation farm. The basic data input package used with both high school and adult classes was organized to represent a small Pennsylvania dairy farm. A generalized flow diagram of the simulation model is shown in Figure 1. A student resource unit, *Farm Business Analysis and Record Keeping*, with a teacher's guide [6], which coordinated with the simulation model, was also developed for the study. The resource unit and the simulation model formed the nucleus of the experimental instructional methods.

Experimental Design

A comparison of five instructional methods was made with high school students as subjects; three of the five methods were also used with adult students. The criterion measures were class mean scores on a subject-matter test and a decision-ability test.² Significance was tested at the 5-percent level. The instructional methods were as follows:

a) Resource unit alone. Each student received a copy of the student handbook and each teacher received a copy of the teacher's guide.

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¹ The development of the simulation model [8] coincided with the development of the research study design. The initial computer program was written in Fortran II and

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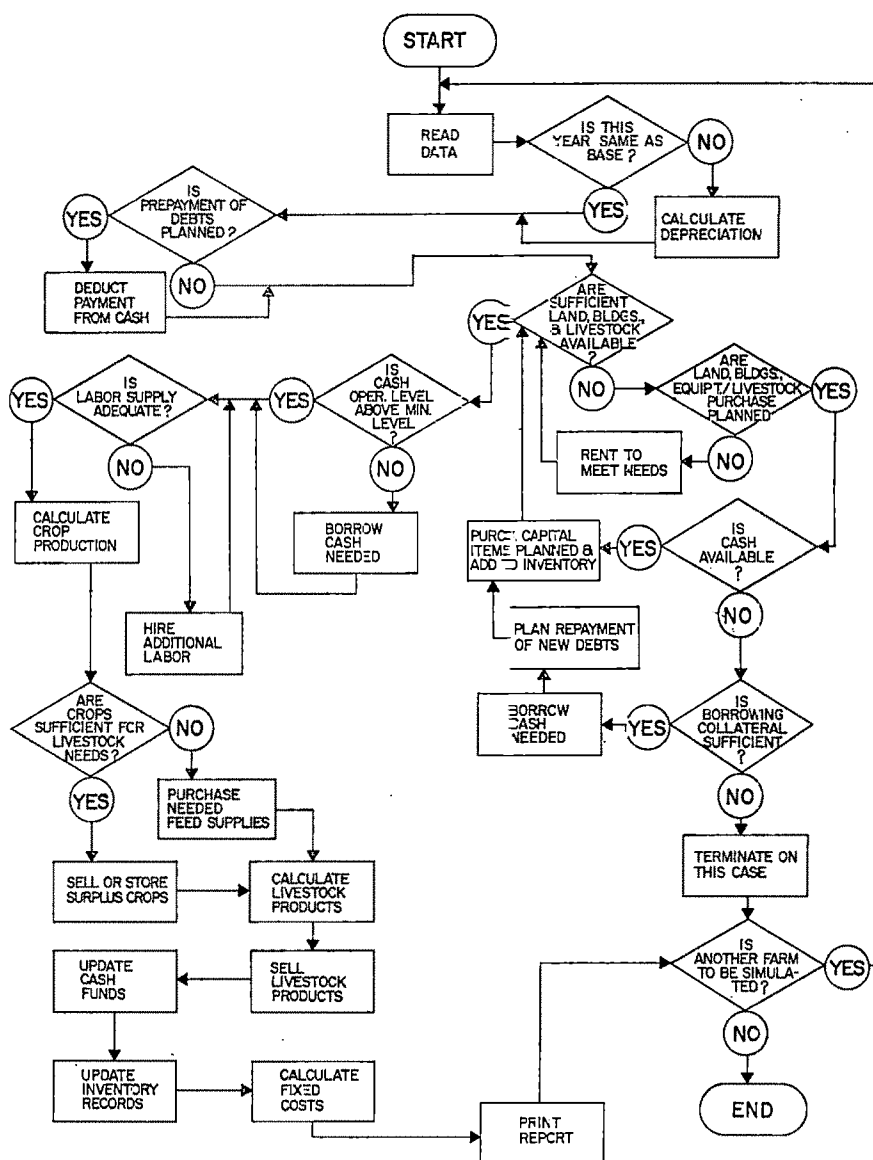


Figure 1. Generalized flow diagram of the farm business simulator used to study the effectiveness of simulation for teaching farm business analysis and record keeping to high school and adult students

b) Simulation model alone. Each student was given information about the farm business to be simulated as well as the decision forms to be used.

c) Combination of resource unit and simulation model. The teaching materials and teaching procedures used in methods *a* and *b* were combined.

d) Course outline alone. The teachers using this method received only a brief course outline.

e) Control group. The course outline used in *d* was given to teachers who had no in-service education.

Methods *a*, *b*, and *c* were used with the adult students.

In-service classes were conducted for the teachers who taught methods *a*, *b*, *c*, and *d* in the experiment to exert a control on teacher differences by providing all teachers, except the control group, with the same subject-matter material and orientation. The simulation model was used in each in-service class. Thus, the teachers were taught how to correlate the simulation with the subject matter in the student resource handbook. The teachers also became familiar with the farm data used later in their high school and adult classes.

The course outline used in methods *d* and *e* was derived from the student handbook. The major headings were "The Decision-making Process," "Budgetary Analysis and Linear Programming," "Measuring Farm Business Efficiency," "Valuation of Farm Inventory," "Keeping Financial Records," and "Keeping Production Records."

In all of the classes (high school and adult) where simulation was used, each student management team (2-4 class members)³ was allowed five decision exercises, one per week. Each decision period was one year. Decision forms were mailed to the investigator and processed on the IBM 7074 computer. The decision to use five exercises for the experiment was

compiled for the IBM 7074 computer. Since that time the simulation program model has been expanded and adapted for the IBM 360/67 computer. Publication of the model can be expected shortly under the title *A General Agricultural Firm Simulator* by Herbert R. Hinman and Robert F. Hutton.

² The subject-matter test was a 40-item multiple-choice achievement test. Test items were selected from the work of previous investigators. Principal contributors were James L. Cook [4] and Floyd G. McCormick [10]. Some changes were made in adapting the material for the purposes and subject matter of the study. The decision-ability test was developed by the author for use in the study. Five decision situations representing five areas of management decisions were devised. Students were asked to weigh the informational items provided and to make a decision based upon the information presented. Five staff members of the Department of Agricultural Economics, The Pennsylvania State University, served on a panel to evaluate the test.

³ Assigning two to four class members to each team assured that at least four different farm plans would be developed in each class. It was considered likely that several plans per class would stimulate discussion and encourage analysis. Another important consideration was the need to limit to a manageable number the plans to be processed on the computer. Since the teams in each class were of comparable size, team size was not a contaminating variable in the experiment.

based on the finding by Litterer [9, p. 31] that student satisfaction with games levels off after six or seven trials. Five decision periods also fitted into the six-week block of time scheduled for the experiment in the schools.

A critique or analysis session followed the return of the simulation report to the students. Each team analyzed its strategy in terms of the results obtained. The discussions included, but were not limited to, the effect of limited resources on farm planning, specialization and diversification in farming, risk due to uncertainty, marginal analysis and its effect on the use of resources, diminishing returns, and the source and value of information. Each critique session lasted approximately one hour. After the critique the teams planned the next year's farm operation. The teacher also taught related subject matter in the intervening time between simulation exercises.

All students were pretested and tested with both the subject-matter and the decision-ability tests. Covariates for adjusting high school student test scores were IQ and pretest scores; for the adult students the adjusting variables were age, years of experience, and pretest scores. These procedures controlled part of the teacher and student variance. Figure 2 is a paradigm of the study.

Results of the Experiment with High School Students

The high school agricultural students received 50 class hours of instruction in farm records and business analysis, regardless of the instructional method used. Four hundred high school students in 25 classes participated in the study. The classes were randomly assigned to the methods of instruction. Mean class size was 16 students. The data for the high school students are presented in Table 1.

To control high school student differences in IQ and in prior knowledge of the subject and decision ability, I adjusted the subject-matter and decision-ability test scores for IQ and respective pretest scores by analysis of covariance.⁴ By means of correlation⁵ and multiple regression⁶ analysis these independent variables were chosen as appropriate covariates. IQ and the subject-matter pretest accounted for 69.6 percent of the variance in the subject-matter test. IQ and the decision-ability pretest accounted for 37.0 percent of the variance in the decision-ability test.

The test results of the high school students are summarized below.

1. Analysis by covariance of the subject-matter test scores of the high

⁴ COV computer library program, *Analysis of Covariance*, The Computation Center, The Pennsylvania State University.

⁵ COREL computer library program, *Symmetric Correlation Program*, The Computation Center, The Pennsylvania State University.

⁶ MREG computer library program, *Multiple Regression with Parsimony*, The Computation Center, The Pennsylvania State University.

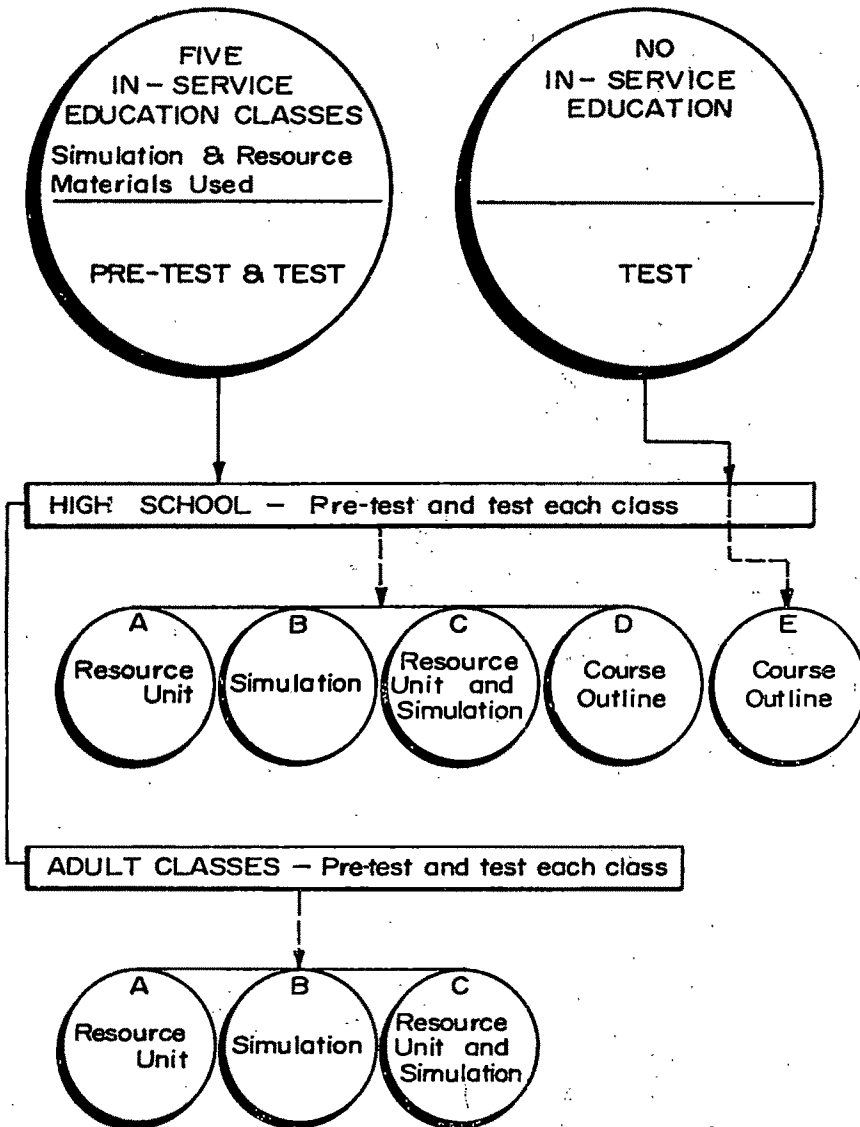


Figure 2. Paradigm of the study of the effectiveness of simulation in teaching farm business analysis to high school and adult students

school classes revealed no significant differences in student learning among the five methods of instruction. Classes taught by the simulation method and the combination method scored as well on the subject-matter test as classes taught by the other methods. It may be concluded that sim-

Table 1. Mean decision-ability and subject-matter test scores of 25 high school classes taught farm business analysis by five methods of instructions

Method	No. of classes	Mean IQ	Mean decision-ability scores			Mean subject-matter scores		
			Pretest	Test	Adjusted test ^a	Pretest	Test	Adjusted test ^a
In-service education and resource unit	5	96.6	13.2	15.2	15.6	12.6	15.0 ^c	16.7
In-service education and simulation	5	100.0	14.0	16.2 ^b	15.6	15.6	18.0 ^c	17.2
In-service education, resource unit, and simulation	6	98.2	12.5	15.3 ^b	16.4	15.5	18.2 ^b	17.8
In-service education and course outline	4	98.0	15.0	15.3	14.3	16.5	17.0	16.1
Course outline alone	5	95.8	13.4	14.3	15.1	15.2	15.4	15.6
Total or average	25	97.7	13.5	15.4		15.0	16.8	

^a No significant differences at the 5-percent level in adjusted subject-matter and decision-ability test scores of students among instructional methods by analysis of covariance.

^b Significant increase over pretest at the 1-percent level by correlated *t*.

^c Significant increase over pretest at the 5-percent level by correlated *t*.

ulation, whether used alone or in combination with the resource unit, was as effective as the other methods tested in this study for teaching farm business analysis.

2. Analysis by covariance of the decision-ability test scores of high school classes revealed no significant differences in student learning among the five methods of instruction. Classes taught by the methods using simulation did not score higher on the decision-ability test than classes taught by methods where simulation was not used. Simulation did not teach decision ability to high school students any better than the other methods as measured immediately after the unit.

3. Other information secured from the data indicated that (*a*) scores were low on both tests and (*b*) gains after instruction were small. Increases over pretest scores were significant (correlated *t*)⁷ on the subject-matter test with the resource-unit, simulation, and combination methods of instruction. Significant increases in scores on the decision-ability test were noted with the simulation and combination methods. The high school students' gain on the subject-matter tests or the decision-ability tests, although significant in some cases, was small regardless of instructional method. The fact that most high school students have limited involvement in actual farm management decision making may explain these small gains. Another explanation may be that the tests and/or the subject matter were too difficult for high school students.

⁷ T-CE computer library program, *Differences Between Means Correlated Samples of Equal Size*, The Computation Center, The Pennsylvania State University. Equations used are from Wert, Neidt, and Ahmann [13, pp. 129-132].

The Results of the Adult Student Experiment

The adult students received 20 hours of instruction in eight weekly classes of two-and-one-half hours each. Eight classes with a total of 76 adult students were taught. Mean class size was 9.5. The data for the adult students are presented in Table 2. The three methods of instruction used with adults were (a) resource unit alone, (b) simulation alone, and (c) combination of simulation and resource unit. The eight classes were randomly assigned to the three instructional methods. To control differences among adult students in age, years of farming experience, and prior knowledge, I adjusted the test scores by analysis of covariance. The covariates for adjusting the subject-matter test scores were years of experience and subject-matter pretest scores; for the decision-ability test the covariates were age and decision-ability pretest scores. From multiple regression analysis it was determined that years of experience and subject-matter pretest scores accounted for 57.4 percent of the variance in subject-matter test scores. Age and decision-ability pretest scores accounted for 37.7 percent of the variance in decision-ability test scores.

Table 2. Mean decision-ability and subject-matter scores of eight adult classes taught farm business analysis by three methods of instruction

Method	No. of classes	Mean age	Mean years of experience	Mean decision-ability scores			Mean subject-matter scores		
				Pretest	Test	Adjusted test ^a	Pretest	Test	Adjusted test ^b
In-service education and resource unit	2	32.5	8.0	15.5	14.6	14.4	21.5	23.0	23.0
In-service education and simulation	3	35.0	12.3	13.7	18.0 ^c	17.3	19.7	27.7 ^c	27.5
In-service education, resource unit, and simulation	3	30.7	8.0	13.8	20.3 ^c	21.3	15.0	24.3 ^c	24.5
Total or average	8	32.7	9.6	14.1	17.3		18.4	25.3	

^a In-service education, resource unit, and simulation method superior to resource unit method at the 5-percent level by analysis of covariance and Duncan's multiple range test.

^b No significant differences at the 5-percent level in subject-matter test scores adjusted for years of experience and subject-matter pretest by analysis of covariance.

^c Significant gain over pretest at the 1-percent level by correlated *t*.

The test results of the adult students were somewhat different from those of the high school students.

1. Analysis by covariance of the decision-ability test scores of adult classes indicated that the classes taught by the combination method scored significantly higher than the classes taught by the resource-unit-only method. It was concluded that with adults the combination method

was more effective in teaching the skills measured by the decision-ability test than was the resource-unit-only method. No significant differences were observed between the simulation-only method and the resource-unit-only method, or between the simulation-only method and the combination method. Adult students taught by the combination method made significantly higher decision-ability test scores than the students taught by the resource-unit method. The conclusion by Babb and Eisgruber that simulation improved the student's ability to understand the importance of systematic analysis [2, pp. 152-154] was supported by the adult experiment phase of this study. Apparently organized subject matter is necessary for the maximum use of the simulation tool.

2. Analysis of the subject-matter test scores of adult classes revealed no significant differences in learning among the three methods of instruction. The adult classes taught with the simulation model alone and with the combination method did as well on the subject-matter test as those taught with the resource-unit method. That simulation can be used for teaching subject matter to adults was demonstrated.

3. It was evident that adult students gained more than high school students on both tests (3.2 points for all adults as compared to 1.9 for all high school students on the decision-ability test; 6.9 points for all adults as compared to 1.8 for all high school students on the subject-matter test). The increases in adult test scores over pretest scores on both tests were significant for the simulation-alone and the combination methods. The fact that adult classes made greater gains than high school classes on both tests would indicate that instruction in farm business analysis and record keeping is more efficient with adult learners.

Conclusions

Simulation or business gaming can be effectively used to teach farm business management to high school and adult classes in agriculture. With adults, the use of simulation when combined with the resource-unit method improved decision skills more than any of the other instructional methods tested.

Thorelli and Graves [12, p. 26], Cohen and Rhenman [3, p. 151], Babb [1, p. 1026] and Babb and Eisgruber [2, pp. 25-28] have indicated that simulation might teach skills other than knowledge of facts. The evidence from the adult phase of this study tends to support that hypothesis, if it can be assumed that the decision-ability test measured facets of learning other than subject-matter knowledge.

Simulation was as effective in teaching subject matter as the more conventional methods. Thus, this study adds to the evidence presented by Babb [1], Babb and Eisgruber, [2, pp. 152-154], Dill *et al.* [7], and McKenney [11] that simulation can be an effective teaching tool for management education. This study tested only one application of the sim-

ulation procedure. The most effective and efficient use of simulation for teaching high school students and adult farmers has not been determined and needs more study. An economic analysis of comparative costs and returns for the various methods of instruction was not included in the study, but the amount of teacher preparation and the hours of student classroom study were the same for all the methods of instruction. Certainly cost analysis, though not included in this study, must be made before simulation can be widely used in the classroom.

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Correction

The following corrections should be made in Gian S. Sahota's article, "Resource Allocation in Indian Agriculture," in the August 1968 issue: On page 590, (a) for the first summation sign, Σ , in equation (1) and the first double summation sign, $\Sigma \Sigma$, in equation (2), read the multiplicative signs, Π and $\Pi \Pi$, respectively; (b) in the last line of the first complete paragraph, for the word *zero* read *one*. On page 599, after the first word of the first line, *where*, insert "the real variables are understood to be in logarithms."

EDITOR'S NOTE: This section of the *American Journal of Agricultural Economics* may include comments on and replies to previous articles and other literature in agricultural economics, suggestions for improving the effectiveness of the AAEA, discussions of changes in emphasis needed within the profession, and contributions on other topics of interest and importance to agricultural economists. Manuscripts submitted for this section should be prepared in accordance with the guide appearing on the inside of the back cover of this issue and should not exceed 1,000 words.

Communications

CONGRESSIONAL BARGAINING IN AGRICULTURE: COMMENT

Field's article on congressional bargaining in agriculture as related to cotton [1] represents a valuable contribution to the broad field of economic research in agricultural policy. His treatment of "East" versus "West" as a two-person, mixed-motive bargaining game is defensible within broad limits. In a two-person bargaining situation, gains and losses may be viewed as possible absolutes or as proportions relative to some base period. Central to the problem of quantifying potential gains and losses in the bargaining process is the matter of identification and measurement, in addition to the choice of base period.

Field failed to recognize alternative means of measuring the relative gains and losses in the congressional bargaining process and to give consideration to alternative outcomes and base periods for comparison. Since other equally or even more appropriate methods of measuring gains and losses provide results that differ from those obtained by the use of acreage alone, one should be cautious in accepting the results as reported in his article.

Using acreage allotments as the

unit of measurement, Field found that "each 1-percent acreage reduction in the east was accompanied by a 2-percent reduction in the west" [1, p. 1]. He then suggested that this ratio could be taken as an index of the distribution of congressional power between East and West [1, p. 11]. Apparently the use of acreage was prompted by the fact that acreages are the means used for limiting production. His measure of gains and losses was apparently based on the outcome of the bill as enacted in the House and is expressed in relation to the 1952 acreage planted to cotton.

The 1952 base would be irrelevant unless a no-quota situation is the alternative. Accepting for the moment the 1952 base and acreages as the unit of measurement, Field placed the final outcome of the bargaining process at coordinates 14 and 29 in Figure 1 of his article. It would seem that an equally valid outcome based on his framework of analysis would have been the bill as finally approved, coordinates 19 and 32.

The potential gross or net income given up by each party would be an-

other measure of the relative strength of the two parties in a bargaining process. In this context, some other unit, such as bales, would probably have been more appropriate than acreages and would have provided different results. For example, yields in 1952 in the West were 2.6 times those of the East and were 2.25 times those of the East in 1953 [3]. When the differences in yield are combined with the differences in acreage "trade-off" obtained by Field, a ratio of 4 or 5 to 1 would appear to be a more defensible index of the distribution of congressional power than the 2 to 1 index developed by Field. Although the results are open to question, cost and returns estimates from cotton production can be used to show that the net returns per bale are approximately the same in the two areas [2].

The proportionality problem comes into play in attempting to measure the gains and losses in the bargaining process. Assume a situation in which producer A in the East had 100 acres of cotton in 1952 and produced 100 bales on the basis of his normal yield. Producer B in the West had 100 acres of cotton in 1952 but produced 250 bales on the basis of his normal yield. If acreages were cut 10 percent in the East and 20 percent in the West, producer A would be cut to 90 acres or 90 bales while producer B would be cut to 80 acres or 200 bales. The percentage reduction from the previous period would be 10 and 20 percent, whether expressed in acres or bales. In terms of absolute losses, producer A has given up 10 bales and producer B has given up 50 bales of production.

Returning to the matter of selection of base period or some point with

which to compare gains and losses, a comparison of the outcome between the situation of no change in legislation and the bill as finally approved would be another means of estimating relative bargaining strengths. It can be seen in Table 1 that, with no change in legislation, the reduction in acreage for the West in relation to 1952 planted acreage would have amounted to 14.5 percent of the reduction in the East, based on the relative distributions contained in Table 2 of Field's article. In comparison, the bill as finally approved resulted in a reduction in acreage from the 1952 planted acreage for the West amounting to 15.8 percent of the reduction in the East. This method of comparison suggests, if one chooses to draw this kind of inference, that the two regions assumed approximately the same magnitude of adjustment or roughly a 1 to 1 index of relative bargaining strengths. On the basis of potential production, the bill as finally approved resulted in a reduction in the West of 43 percent of the reduction in the East, compared to almost 40 percent if there had been no change in legislation—again, roughly a 1 to 1 ratio.

One important aspect of measuring relative bargaining strengths in shaping agricultural policy is the matter of determining the costs and returns of the resources used in the bargaining process. Such an analysis would include the opportunity costs of the resources used by the parties involved to achieve legislative bargaining.

These wide ranges of possible outcomes should not be taken lightly. They serve to indicate the importance of the selection of outcomes to be measured in the bargaining process,

Table 1. Comparison of reductions in cotton production in the East with those in the West, under conditions of no change in legislation and under the bill as finally approved for 1954

Description	East	West	West as a percentage of East
1952 planted acreage (millions of acres)	25.66	2.40	9.4
A. With no change in program			
Reduction from 1952 planted acreage (percent) ^a	33	51	
Reduction from 1952 planted acreage (millions of acres)	8.47	1.22	14.5
Reduction in potential production from 1952 production (millions of bales)	3.97	1.57	39.5
B. With bill as finally approved			
Reduction from 1952 planted acreage (percent) ^a	19	32	
Reduction from 1952 planted acreage (millions of acres)	4.87	0.77	15.8
Reduction in potential production from 1952 production (millions of bales)	2.28	0.98	43.0

^a Computed from data given in Table 2 of Field's article [1].

the base from which these outcomes are to be measured, and the units of expression.

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CONGRESSIONAL BARGAINING IN AGRICULTURE: REPLY

Brooks has raised a number of points concerning the terms in which I expressed the relative power of eastern and western cotton-growing interests in the congressional bargaining episode of 1953-54. Noting that the world is describable in a number of

different ways is of little use, however, unless it is accompanied by efforts to find reasons for preferring some ways over others. Brooks shows that different calculations will give different expression of relative power, but does not disclose the criteria by which

these alternatives are judged to be "equally or even more appropriate." I would certainly not argue that the expression I used would remain valid in the face of any and all theoretical interpretations of the 1953 bargaining episode; it was meant primarily to summarize the results of the bargaining. Nevertheless, I believe that it has a considerable amount of common-sense justification, and more than the alternatives proposed by Brooks. My reasons are as follows:

1. Use of 1952 as base year. Though the allotment formula finally agreed upon was first used in 1954, the bargaining process leading up to it actually began in the spring of 1953. This is probably the reason why the legislators themselves used 1952 as the base year. It is certainly not true, of course, that concepts and quantities used to study decision making must always depend for their analytical usefulness on their having been in the minds of the people under study. In this case, however, the explicit "currency" of the bargaining process was in terms of changes from 1952 acreages.

2. Use of percentage reductions in acreage. To some extent the same reasoning applies here: the allotment formulas that were made by the two sides were in terms of percentages of 1952 planted acreage, and I interpreted them, as most legislators obviously did, in terms of percentage reductions that would be required in each of the cotton-producing states. Brooks suggests that the analysis might have been cast in different terms, with output or income figures rather than acreages. He recognizes that the percentage changes will be the same irrespective of whether one calculates them from acreage, outputs,

or income figures, provided that there is stability in yields and prices. Thus, his statement that "when the differences in yield are combined with the differences in acreage . . . , a ratio of 4 or 5 to 1 [is obtained]" is in error. When one group gives up 2 percent of its acreage in return for a reduction of 1 percent by the other group, the two groups will also be trading percentage reductions in output and income in the same proportions. While we know *ex post* that yields and prices changed somewhat, the use in 1952 of current prices and yields to project the value of an acre of cotton several years hence would not to me constitute unreasonable behavior on the part of participants in the bargaining. The real question, then, concerns the use of percentage rather than absolute changes. The West was finally cut back 0.77 million acres and the East 4.88 million acres. On this basis (and similar measures for absolute changes in output or income), the conclusion might be drawn that the West was about six times more powerful than the East, for it apparently had to give up only 0.16 acres for every acre of reduction in the east. It is only when these figures are rendered in percentage terms that they become meaningful rather than bizarre.

3. Use of the House bill rather than the conference bill. I stand guilty of not stressing in my article that the 2 to 1 terms of trade were for the bill as passed by the House and not as finally approved by the whole Congress, for which the ratio was 1.7 to 1. The reason for my disproportionate emphasis on the House bill was that it passed on July 31, 1953, whereas the Senate did not reach agreement until January of the following year. Between these

two dates, Secretary Benson announced a 17-million-acre allotment for 1954. This represented a 40-percent reduction nationally from 1952, 5 percent more than had been anticipated earlier, and changed somewhat the context in which the bargaining took place. There are two plausible reasons for the difference between House and conference bills. One is that the western interests were relatively more powerful in the Senate than in the House. The other is that, before the announcement of a 17-million-acre allotment for 1954, the bargaining problem was a straightforward one of finding an acceptable formula for reducing acreage in each state; after the announcement, it was essentially one of adding back enough acreage to the announced figures to bring states up to acceptable levels. Conflict theory would suggest that the West was likely to receive more favorable treatment when acreage was being added than when it was being reduced. Being concerned to make a comparison of the outcome in 1953 with one reached earlier, I used the 1953 House bill as most closely resembling the bargaining context of 1949. I would agree, however, that from the standpoint of the whole Congress, the 1.7 to 1 ratio is to be preferred to the House's ratio of 2 to 1.

4. Use of the "no change" alternative as base. Using as a base the world as it would have been with no change in legislation instead of the world as it actually was in 1952 is an interesting proposition. One does indeed get a new number that can be called an "index of power," even though its exact meaning is left in doubt. Though Brooks does not attempt an interpretation, I think that it can be given a useful meaning. Before

discussing this possibility, however, I should like to dissent from the conclusion drawn by Brooks that using this approach "suggests . . . that the two regions assumed approximately the same magnitude of adjustment or roughly a 1 to 1 index of relative bargaining strengths." By neither measure, percentage or absolute, did the two regions assume the same magnitude of adjustment. To say that the relative adjustments called for in the approved bill were roughly equivalent to those implied in the "no change" alternative is not the same as saying that the two adjustments were of the same magnitude. The implication of his sentence is that we should deem two sides in a bargaining process equal in strength when the relative adjustments called for in approved bills are roughly the same as what would have resulted had there been no program changes. With no change in the law, the western acreage would have been reduced 1.5 percent for each 1 percent reduction in the East. In the approved bill the ratio was 1.7 to 1, a worsening in the terms of trade of 0.2 percentage points from the standpoint of the West. Thus, we might say here that, whereas with "equal" power the trade-off would have been 1.5 to 1, the West's disadvantage in power actually resulted in a trade-off of 1.7 to 1, implying a "relative" power position of 1.7/1.5 or 1.13 in favor of the East.¹ Expressing

¹ In this section of his comment, Brooks computes the ratio of acreage decrease to original acreage for the East and for the West. The ratio of these two ratios is used in turn to draw the conclusion that power was equal. This method is mathematically equivalent to the one which I have used, the numerical difference in final ratios arising from rounding. Brooks might have followed the logic of this

relative power simply as 1.7, as I did in my paper, implies that we would call the two sides equal in power whenever the adjustment was 1 to 1.

The relative power position based on the no-change alternative might be usefully interpreted as the "incremental" power positions in the bargaining process. The 1.5 to 1 ratio implied in existing legislation may be viewed as the relative positions of advantage resulting from past bargain-

ing episodes, and the change to 1.7 to 1 a result of the "incremental" power brought to bear in the 1953 bargaining. This reasoning is largely intuitive, of course; a rigorous statement concerning the most appropriate treatment of these numbers must wait on a full theoretical investigation.

Brooks states that the question of determining costs and returns of resources used to obtain bargaining power in political processes is an important one and ought to be investigated. I agree. There is a slowly accumulating theoretical literature on this subject, though little has appeared in the economics journals. What is needed quite as much as theory, however, is a growing stock of empirical studies showing just how and why bargaining agreements are reached and what they imply about congressional trade-offs.

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position to generate yet another index of power. With no change in the program, 1954 allotments would have been 17.19 million acres in the East and 1.18 million acres in the West. In the approved bill they were, respectively, 20.79 and 1.63. The latter figures represent increases over the former of 20.9 percent for the East and 38.1 percent for the West. The ratio 38.1:20.9 apparently shows that the West was nearly twice as powerful as the East. Further shopping around would undoubtedly yield other numbers, the only question being whether they had any meaning.

EFFECTS OF NONPRICE VARIABLES UPON PARTICIPATION IN WATER-ORIENTED OUTDOOR RECREATION: COMMENT

The recent article by Gillespie and Brewer [2] moves me to comment, partly because my reaction to it applies to several recent studies on the demand for outdoor recreation. My present concern is not with their model (although that, too, might be criticized) but with their concluding section, "Applications," in which they state that their method "may be used for predictive purposes" and that the estimates so obtained "indicate a degree of reliability acceptable for planning purposes." These and related statements on applications do not logically follow from their analysis and may, in fact, be seriously in error.

Their analysis applies to a single point in time. Their application assumes that the coefficients between age, income, and other socioeconomic variables, on the one hand, and recreation use or participation, on the other hand, will remain constant over the course of time. It is precisely this implicit assumption that I wish to challenge. My best, but extremely rough, estimates of past changes in recreation use suggest that such coefficients have changed greatly in the past; and this at least suggests that they may change significantly in the future.

Fortunately, it is not necessary to rely wholly either on their tacit as-

sumption or on my challenge to it. The assumption about constancy of such coefficients could be tested for the past by some "backward" projections. If their coefficients of present relationships between socioeconomic variables and recreation participation are really valid over the course of time, then they should prove usable for smaller as well as for larger values for the different variables. I suggest that they, or some other researchers, take some recreation area where past and present total attendance are known, and where similar coefficients have been estimated, and calculate attendance for such items as a smaller population, a lower per capita real income, and less education, using figures corresponding to the situation in 1950, 1940, 1930, or any other past dates for which the necessary socioeconomic data and recreation area attendance data are both available. If, as I believe will be the case, such calculated or estimated attendance figures at some past date greatly exceed the reported attendance figures at that date, then it will be clear that some of the coefficients have shifted over one time period. Such an analysis would not measure which coefficients had changed, or by precisely how much, although it might give some hints.

The use of assumed constant coefficients between socioeconomic variables and outdoor recreation activity,

on the one hand, and the use of projected future population, income, and other variables on the other hand, is becoming rather common. The Outdoor Recreation Review Commission, for example, used this method in making its estimates of future demand for outdoor recreation [3]. I am sure that this method would have been invariably wrong in the past, although I have not tested this assertion fully. But even if the method would have been wrong in the past, it still might give correct answers for the future; I feel sure, on the basis of my studies, that some of the past shifts cannot continue indefinitely. But I do not think that one should blandly assume that this will be the case nor—as Gillespie and Brewer seem to have done—make this assumption without realizing its lack of objective basis.

I certainly welcome research on outdoor recreation, by many different workers and different approaches; only in this way will the full relationships be unearthed and tested. But the warning that Jack Knetsch and I issued some years ago is still valid: "Premature reliance on untested research might bring the whole concept of research into disrepute; for the next few years, we shall have to continue to rely heavily on the intuitive approach which is inadequate for the longer run" [1, p. 274].

MARION CLAWSON

Resources for the Future

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EFFECTS OF NONPRICE VARIABLES UPON PARTICIPATION IN WATER-ORIENTED OUTDOOR RECREATION: REPLY

We appreciate Mr. Clawson's comments on our recent article in this journal, and we wish to take this opportunity to discuss some of the questions he has raised.

First, we would like to emphasize some of the positive aspects of the research. This effort was one of the first research projects in which a statistical sample of a metropolitan population was interviewed, valid statistical procedures used to analyze the data, a method developed, and a set of conclusions reached regarding the recreation participation of a metropolitan population. We believe this procedure, despite its alleged shortcomings, to be far superior to "rough estimates" used in an "intuitive approach" advocated by Mr. Clawson.

Clawson questions the application of the research and suggests its deficiencies for predictive purposes. We fully realize that the coefficients derived may change over the course of time. Our suggestion was that the method developed "may be used for predictive purposes" and that estimates "do indicate a degree of reliability acceptable for planning purposes." We assumed that an intelligent planner would use his own professional judgment in a specific planning problem, along with the method we developed. Perhaps we were too presumptuous. We seriously doubt that Clawson is correct when he says, "These and related statements on applications do not logically follow from their analysis and may, in fact, be seriously in error." Perhaps it depends on the relative naïveté of the user of

the method suggested. Certainly, each location has its own peculiar set of circumstances.

The suggestion of proving constancy of coefficients by using "backward projections" is open to question. The changes in the supply of recreation facilities alone would be an overriding factor affecting the change in participation. The collected participation data which have been influenced by these supply changes seem more relevant to our problem than data from 10 to 30 years ago.

One of the greatest obstacles to recreation research has been and still is the lack of acceptable data. Another is the lack of a standardized terminology. The causes of these conditions and the problems which they pose are too numerous to discuss here.

We believed when we undertook the research that an exploration of the likes and dislikes of a known population, their preferences, and their participation in outdoor recreation activities would provide a better base from which to estimate demand for recreation than would secondary data. We remain strongly convinced that a systematic method using primary data, and hence the development of coefficients, is better for predictive purposes over a reasonable time period than subjective methods.

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AGRARIAN STRUCTURE IN RELATION TO FARM INVESTMENT DECISIONS AND AGRICULTURAL PRODUCTIVITY IN A LOW-INCOME COUNTRY—THE INDIAN CASE: COMMENT

Professor Bela Mukhoti develops an interesting but questionable policy prescription for raising productivity in India [4]. She divides farms in India into three sectors but confines her discussion to Sector A (small cultivators owning 5 acres or less) and Sector C (large cultivators holding 15 acres or more). Sector A is designated as the supplier of labor to Sector C, while Sector C is described as the supplier of credit to Sector A. Professor Mukhoti concludes that (1) the large cultivators do not invest their capital on their farms because the returns from trading are better than returns from farm investment, and (2) the output per acre on small farms is higher than that on large farms. Following this line of reasoning, she recommends that, to increase production in India, land should be redistributed from Sector C to Sector A.

Professor Mukhoti's first hypothesis reads: "The very nature of agrarian economy provides the larger farmers with alternative and more remunerative investment opportunities than farm investment" [4, p. 1212]. To one familiar with the Indian scene, the statement that "trading has been found to take the form of investing in stocks, hoarding and creating artificial scarcity, or augmenting existing scarcity" [4, p. 1212] clearly smacks of the practices indulged in by the professional trader who often is also the money lender. However, the large cultivator is primarily involved in marketing his own produce and only secondarily in trading the produce acquired from others.

Professor Mukhoti suggests that the large cultivator enjoys monopolistic and monopsonistic gains. This conclusion is questionable considering the following: (1) there are a number of large cultivators in any given area; (2) not only is the contribution of the Sector A cultivators to market supply substantially less than that of the other two sectors, but also not all of it passes through the hands of the large cultivator [3, p. 261]; (3) selling of his own produce apart, trading in commodities and lending by the hereditary large cultivator have been traditionally frowned upon and therefore seldom practiced in India [2, p. 622]; and (4) as the debtor has the alternatives of selling his produce in the local market or to the village trader or the itinerant merchant, the large cultivator-creditor is in no position to influence the price he pays if he wants to acquire the produce of the debtor.

The foregoing arguments indicate that the lack of investment in farming cannot be attributed to the trading advantages enjoyed by the large cultivator. In fact, the trend during the sixties has been one of stepped-up farm investment. The lack of investment observed during the earlier period could be traced to the causes like the following: (1) uncertainty of tenure caused by the vacillating "land-to-the-tiller" philosophy of the ruling political party, which robbed the landowner and the tenant alike of incentives to make improvements of a permanent nature in land [2, p. 622]; (2) the relative cheapness of labor,

with the result that the rational farm investment strategy could not but be labor-high and capital-shy; (3) the incentives arising out of the favorable relation between input and output prices, which have, generally speaking, been minimal in India (Malone illustrated this point by citing the price relation between fertilizers and rice [3, pp. 266-267]; (4) inadequate farm size, which rendered capital investment in farm machinery and equipment uneconomical; and (5) poor response of popular crop varieties to inputs such as inorganic fertilizers, which discouraged intensive use of such inputs.

To the extent that the preceding drawbacks remain operative during the sixties, farm investment continues to be at a level lower than otherwise seems warranted. Available evidence has nevertheless already indicated that, given proper incentives, the requisite investment on adequate-sized farms should not be lacking. High farm prices during the sixties have already significantly stimulated farm investment. Previously reluctant landowners are now known to be installing pumping sets and purchasing tractors and other farm machinery [1, p. 91]. The large-scale introduction of short-duration, high-yielding, hybrid varieties of food grains is encouraging, for it necessitates and speeds up farm mechanization [6, p. 4]. These relatively recent developments suggest that the lack of farm investment can be corrected by eradicating the drawbacks rather than by increasing the number of uneconomical holdings through redistribution of land.

Professor Mukhoti's second hypothesis is that the large cultivator pays wages and therefore does not employ

labor beyond the point where marginal value product of labor equals its marginal factor cost (the wage rate). She suggests that the small cultivator, by contrast, employs labor until the marginal product of labor, given a fixed quantity of land, becomes zero. He is supposedly able to do so because the opportunity cost of his family's labor is zero. Professor Mukhoti admits that if an "institutional" wage rate were to be used as the determinant of the optimal employment of labor, it would be uneconomical for the small cultivator to produce beyond the stage where marginal value product of labor equals its marginal factor cost, but she dismisses the loss so incurred by the small cultivator as a mere accounting loss. Use of family labor on small farms up to the point where marginal value product of labor is zero is suggested to account for the supposedly higher output per acre on these farms. However, this does not necessarily seem to be the case.

Malone's study of Tanjore district indicated, for instance, that the yield of rice per acre on the small farms was no higher than that on the large farms. It also revealed that the extent of double-cropping of rice on the small farms was no higher than that on the large farms. Professor Mukhoti's hypothesis is logically and factually inconsistent with findings like those of Malone. Still more telling is that part of Malone's findings that highlighted the usually overlooked fact that even the small and very small cultivators hired labor, even though the bulk of the available supply of their own family labor remained unemployed over the same period [3, pp. 259-260]. Given such evidence, there appears to be little basis for any theoretical con-

structs being erected on the assumption of significant advantages in productivity accruing to small farms as a result of free family labor.

The argument that income per acre is larger on the small farm than on the large farm will also not help retrieve Professor Mukhoti's hypothesis. The fact is that the relatively greater income per acre on small farms arises from supplementary enterprises undertaken because of the need to use the few available nonlabor resources fully and not because of the advantages arising out of the overuse of free family labor.

Static remedies can hardly solve dynamic problems. Professor Mukhoti's recommendation leans heavily on the possibility of taking advantage of the existing surplus supply of labor on the small farms. This situation, however, is necessarily transitory in nature. In-

creasing industrialization is steadily opening up off-farm employment opportunities for surplus farm labor. The spread of education is likely to facilitate and accelerate this process even further. The number of children going to school has trebled since 1947, while industrial output has more than doubled [5, pp. 1 and 5]. Unemployed and underemployed family labor is thus likely to leave the farm at an increasing rate. As a result, any policy stemming from the supposed advantages accruing from free family labor has little chance of success. Furthermore, there is a great need for eliminating rather than perpetuating the colossal social waste emanating from the failure to employ productively the millions of idle or near-idle farm hands.

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AGRARIAN STRUCTURE IN RELATION TO FARM INVESTMENT DECISIONS AND AGRICULTURAL PRODUCTIVITY IN A LOW-INCOME COUNTRY—THE INDIAN CASE: REPLY

I am grateful to Mr. Gill for making some interesting comments on my paper. Unfortunately, instead of making any original investigation to support his ideas, he has rejected my hypotheses almost entirely on the basis

of several preconceptions. In fact, examination of the articles quoted by Gill leaves one with the impression that, if anything, they support my hypotheses rather than his.

First, he objects to my hypothesis

that "the very nature of agrarian structure provides the larger farmers with alternative and more remunerative investment opportunities than farm investment" [6, p. 1212]. As alternative explanations for less investment and lower productivity on large farms, Gill puts forward some oft-quoted factors. Most of these factors operated, and still operate, against agricultural improvement in India, irrespective of farm size. The point at issue is to explain the greater investment and higher output per acre on small farms, despite those hindrances.

Second, with respect to the possible monopoly or monopsony power of the large cultivators, he ignores the data that I used, which are the most comprehensive available [1]. When only 6 percent of the rural households own 50 percent of the land, with 75 percent of households owning only 17 percent, and 47 percent of the families are landless and without alternative means of subsistence, the possibility of a monopoly situation can hardly be dismissed so casually.¹

The rest of Gill's comments indicate some misunderstanding of the subject at hand. His apparent belief that, in agriculture, size is closely correlated with productivity, and farm investment is synonymous with mechanization, is uninformed. The Farm Management Reports [2] have largely disproven this idea, as have a number of recent articles [4, 7, 9, 10]. Apparently he fails to distinguish between the yield per acre of one crop only, in this case rice, and the total output on a particular farm. *Output* is defined in the Farm Management Reports as the total gross income comprising the

value of all produce raised on the farm evaluated at the harvest rate prevalent in the village. What a land-scarce country such as India is interested in, is the total output of farms over a period of time.

The Farm Management Studies² found that the values of human labor applied per acre [2, Punjab Report, 1956-57, p. 79] as well as intensity of cultivation [2, Punjab Report, 1957-58, p. 27] increases consistently with the decline in farm size; but whereas the large farmers earn cash profit, the small ones maximize income over out-of-pocket expenses actually incurred, by maximizing output [2, Punjab Report, 1966-67, p. 55]. The dynamic context of increasing agricultural productivity, when all the facilities have been made available to the farmers, is of still greater interest for our present purpose. A comparison of the rate of increase in the value of output per acre in different sizes of farms in Punjab over the period 1954-55 to 1956-57 sheds some light on this subject (Table 1). As the data relate to the period of the end of the First Plan and the beginning of the Second Plan, they indicate roughly how different sizes of farms have responded to the productivity-increasing stimulus of the huge expenditure in the public sector during the First Plan.

For the sample farms in Punjab, the average value of output per acre increased about 64 percent over the period 1954-55 to 1956-57. The smallest farms had an increase of 111 percent (from Rs. 119 to Rs. 351.10). The increase in the value of output per acre

¹ For a possible means of testing the monopoly hypothesis, see Wharton [11].

² All the reports for each of the six states show similar data in almost all important respects, and hence, for convenience, reference is restricted to one report only, that on Punjab.

Table 1. Value of output per acre for different sizes of farms and increase over period 1954-55 to 1956-57, Punjab, India

Size of farms	Output per acre			Increase in value of output
	1954-55	1955-56	1956-57	
<i>acres</i>	<i>rupees</i>			<i>percent</i>
0-5	119	176.53	251.10	110.9
5-10	116	170.49	208.67	78.8
10-20	115	169.35	193.72	68.4
20-50	112	142.61	183.70	64.0
50 and over	113	159.61	146.96	30.0
Average	114	156.33	187.10	64.1

Source: *Studies in Economics of Farm Management* [2, Punjab Reports, 1954-55, p. 65; 1955-56, p. 59; 1956-57, p. 55].

for the largest farms was only 30 per cent (from Rs. 113 to Rs. 146.96). It is in the size-group of 20-50 and above that the increase has been less than average.³ This group of farms, which comprises more than half of the cultivated area (about 57 per cent) is mainly responsible for bringing down the overall average to 64 per cent.

An analysis of the various crops produced on farms of different sizes and their relative price changes does not suggest that the price changes have been more favorable to small farms than to large ones. It may therefore be assumed that the price changes have affected farms of all sizes equally and that consequently the relative increase in value of output indicates mainly increased production. Changes in average yield per acre of individual crops do not indicate any pattern as between sizes of

farms, and the increases seem mainly to have taken the form of increased intensity of cultivation on small farms. Whereas the intensity of cultivation in the largest farms decreased from 145 per cent in 1954-55 to 117 per cent in 1956-57, in the smallest group it increased from 150 in 1954-55 to 171.8 in 1956-57 [2, Punjab Reports, 1954-55, p. 43, and 1956-57, p. 27]. Hence, it appears that, taking advantage of the irrigation and other facilities provided during the First Plan, the small farms have resorted to multiple croppings to a greater extent than before and have consequently recorded a higher rate of increase in the value of output per acre. The higher value of output on large farms, on the other hand, appears to have resulted mainly from the higher prices of agricultural commodities in 1956-57 rather than from an increase in yield. Although generalization is not possible because of the very short period of time under consideration, there appears to be some indication that small farms are likely to be more responsive to productivity-increasing stimuli than large farms. Malone appears to confirm my contention in the article cited by Gill [5]. On the basis of a survey of several hundred rice farms in a single district,

³ The value of output may be influenced by the price of the products irrespective of changes in yield. Price of almost all the agricultural commodities in 1956-57 was higher than that in 1954-55 in the sample villages in Punjab. Hence, what is of significance here is not the absolute increase but rather the relative percentage changes in various size-groups.

Malone estimated the responses of the farmers to the Package Program. After analyzing the performance of the small and very small farmers, he concludes that "it may be that we find more of the innovators in this group, which is hardly where most observers would first look for them" [5, p. 262.] Malone, however, does not go into the reason for higher income on small farms from supplementary products such as minor crops, vegetables, fruit, and milk. He dismisses this matter by saying that "the small farmer, being under great pressure to use his few resources fully, pays more attention to supplementary enterprises than the farmer with more land" [5, p. 260]. This does not explain why the large farmers fail to do so. Herein lies my hypothesis about the implications of wage cultivation as against non-wage cultivation for intensity of land use and output.

Gill's apparent belief that unemployed and underemployed agricultural labor in a country such as India will soon be fully utilized because of education, industrialization, and the consequent out-migration from agriculture is not well founded. Although economic growth in general involves the absorption by industries of the surplus rural population (thus raising the per capita income of the remaining agricultural population), it is being increasingly realized that, in countries with heavy demographic pressure, substantial industrialization has to take place before the number of people on the land can even be stabilized, let alone reduced. Even Japan, with a high degree of literacy among the farm population and a remarkable rate of industrial growth, has needed several decades to be in a position where increase in her nonag-

ricultural employment opportunities can more than absorb all increments to total population, thus allowing an absolute reduction of farm labor force. Estimates which I have seen paint a gloomy picture of India's prospects for population transfer [3, 8].

On the basis of an average of four projections for India⁴ and the occupational pattern reached by the developed countries at a stage of their economic growth which roughly corresponds to what India could be expected to reach by 1931,⁵ Rao has made an estimate in this regard. The most plausible of Rao's estimates shows that the proportion of population dependent on agriculture is likely to fall from 72 percent in 1951 to 56 percent in 1981; but in spite of an absorption of 67 million persons by other sectors, the pressure on land will increase by 40 percent and agriculture will have to absorb 40 million additional persons in 1981 [8]. This finding is corroborated by Khusro, who comments: "The hard fact must now be faced squarely that agricultural population cannot be displaced in the course of the Third, Fourth or the Fifth five-year plans" [3, p. 80].

With such a prospect of future pressure on land in India, there is little economic advantage in advocating an agricultural organization that leaves millions of families without land. On the contrary, it indicates that, in order to step up agricultural production and land development, it is imperative to reorganize agricultural production in a way that will

⁴The 1931 Census has proved the four projections used to be gross underestimates.

⁵Japan of 1920, U.S.S.R. of 1938, and U.S.A. of 1920 [8].

make possible the use of more labor per acre so that these millions of landless families may be effectively absorbed in agriculture. With the growth of the economy and the easing of pressure on land in the distant future, increase in farm size will of course

eventually be possible; but, for a long time to come, small farms will prove best for augmenting agricultural production.

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PRICE DISCRIMINATION IN THE WORLD TRADE OF AGRICULTURAL COMMODITIES: COMMENT

In a recent and provocative article ["Price Discrimination in the World Trade in Agricultural Commodities," *J. Farm Econ.* 48:194-208, May 1966], Martin E. Abel uses a simple price discrimination model to show that, when faced with minimum-import-price schemes, an exporting country may increase profit by charging higher prices in foreign markets. Without challenging his major conclusion, I wish to point to an apparent

error in the graphical representation of the total market situation—an error which causes Abel to reject the "usual assumption of equating the marginal cost of the total output with the marginal revenue of each of the markets" [p. 205]. It will be seen that the usual rule, in fact, still holds if the correct marginal revenue curve is constructed.

Figure 1 reproduces part of Abel's diagram [Fig. 7, p. 205] showing the behavior of a discriminating monopoli-

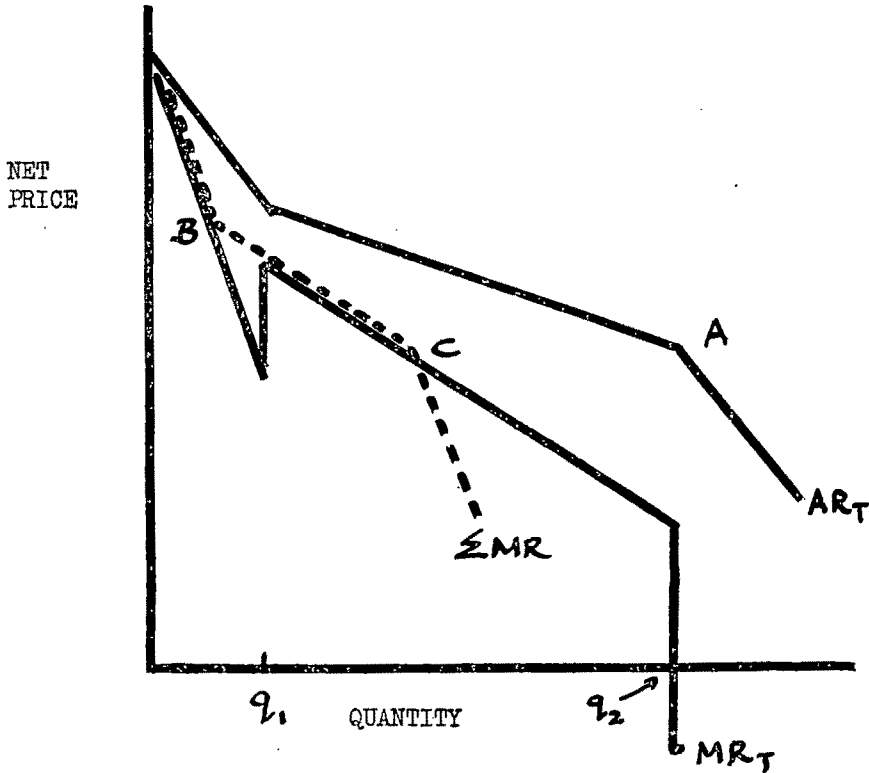


Figure 1. Total market average and marginal revenue curves, in the presence of a minimum-import-price scheme

list faced with a minimum-import-price scheme in the (normally more elastic) foreign market. AR_T is the total market demand curve, formed by summing horizontally the AR curves of both separable markets. MR_T is the curve "marginal" to AR_T and is discontinuous at two outputs. When the first unit (at q_1) is sold in the second market (that with a lower intercept on the price axis for its demand curve), AR_T becomes more elastic and total market marginal revenue rises sharply. Demand in this second (export) market suddenly becomes completely inelastic at the imposed minimum import price, and total market

demand kinks down at A. No extra revenue is forthcoming in this export market, and MR_T drops sharply after q_2 units are sold.

It is important to realize under what conditions the horizontal summation of the demand curves makes sense. For any point on AR_T , say A, to give the average revenue over q_2 units, the price must be the same in both markets. The curve MR_T is the relevant curve for the nondiscriminating monopolist, at least up until q_2 .¹ Abel,

¹ After q_2 , it will be costly if not impossible to sell at the same price in both markets, and there will be added pressure to discriminate.

however, is considering the case of a discriminating monopolist [p. 204]. Since he will equate marginal revenue in both markets, his relevant total market MR curve is the horizontal summation of the individual MR curves, labeled ΣMR in Figure 1. This curve also has two kinks in the face of a minimum import price, the first corresponding to the first unit in the second (export) market, at B , and the second occurring at C , where the MR curve in that market drops to zero—at the quantity which can be sold for the minimum import price.²

² Up to C , the ΣMR can be derived geometrically from AR_T by halving the horizontal distance to the price axis. The convenience of this geometric trick hides the fact that this curve is distinct from the MR_T curve, although coincident with it over a range of outputs, and has a different economic meaning. It is not really a marginal revenue curve in the usual sense; it is more a "decision curve," which indicates that, at any point on it, output can be distributed among markets in such a way that marginal revenues are equal. One would expect his actual revenue increment to be higher than that of the nondiscriminator for any increase in output—the reward for his discrimination. This raises the conflict between intuitive argument based on discrete marginal units and the results of the calculus with its assumption of divisibility. This will not be explored here.

Using the correct marginal revenue curve, one can find the best distribution of output between the two markets. In Abel's example, MC meets MR_T at 90 units of output. He states:

The monopolist will sell 40 units in the export market at a price of 60, and 47.5 units in the domestic market at a price of 62. This leaves 2.5 units unsold. The monopolist can increase his total net revenue by selling 50 units in the domestic market at a price of 60. This violates the usual assumption of equating the marginal cost of the total output with the marginal revenue of each of the markets [p. 205].

Selling in both markets for a price of 60 is just the behavior that one would expect from a nondiscriminating monopolist, to whom the curve MR_T is relevant; the discriminating seller, judging from Abel's graph, would produce some 87 units ($MC = \Sigma MR$) and distribute 40 to the export market, sell 47 at home, and maintain different prices. Abel's esoteric explanation, that the violation of the equal marginal revenue rule "stems from the peculiar nature of the marginal-net-revenue curves," and is "a common problem when demand curves, whether linear or curvilinear, are added" [p. 205] proves unnecessary if the correct marginal revenue curve is used.

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PRICE DISCRIMINATION IN THE WORLD TRADE OF AGRICULTURAL COMMODITIES: A REPLY

I want to thank Professor Josling for calling attention to the improper use in my article on price discrimination of the total marginal revenue curve in the case of a discriminating monopolist. The conclusions of my ar-

ticle are not affected by the approach suggested by Professor Josling, but the economic analysis is significantly improved.

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BARGAINING POWER POTENTIAL IN AGRICULTURE*

Farm groups have many ways of increasing their returns from the sale of their products. These include reducing the amount of product marketed, discriminating among markets in the sale of their products, performing various marketing functions, increasing consumer demand for their products through advertising and quality control, and bargaining away some of the middlemen's marketing margin. This communication concerns the last method of increasing farmer returns. It is my thesis that farmers can effectively bargain for marketing margins only with the first handlers of their products and that the amount which can be obtained from this source is practically nil in the long run except where first handlers have extraordinarily high profits or add a large value to the product.

The conclusion that bargaining gains from the marketing margin must come from the first handler's portion of the margin is drawn from two facts: (1) that it would be virtually impossible for producers to negotiate on prices with firms other than those to which they directly sell and (2) that the first handler when acting rationally has already obtained as much as he can from succeeding handlers under existing supply and demand conditions.

If we accept this argument, the next step in the analysis is to look at the data to see what part of the first handler's marketing margin farmers might in fact bargain away. Average processor margins for seven major

foods consist of labor and fringes, 35.4 percent; containers and supplies, 19.3 percent; buildings and equipment, 6.7 percent; advertising and promotion, 4.6 percent; other expenses, 22.6 percent; and profits before income tax, 11.4 percent.

The only one of these items which, it would appear, farmers might logically be able to bargain away is profits, the part of the marketing margin that is in fact the residual after all other factors have been paid. The prices of the other items are set largely in their respective interindustry market places or by government regulation, thus putting them out of the reach of negotiations between farmer and first handler. It does not appear likely, at least in the short run, that farmer bargaining can reduce wage rates, salaries, transportation costs, taxes (other than income taxes), depreciation, interest, rent, or costs of electricity, containers, advertising, fuel, building, and equipment.

If we assume that first-buyer profits are the only significant part of the marketing margin which farmers might expect to bargain away, how great are these profits in relation to farm prices at various profit levels for the processing firms? Profits can be measured in two ways, before and after taxes. Which is the relevant figure to consider? The answer is profits before taxes, because taxes on profits are not paid unless profits are actually made. Because corporate income taxes are approximately 50 percent of net income, about one-half of the amount that is bargained away from a firm comes out of its reduced tax liability.

The profit made per unit handled

* This communication benefited from the comments of John M. Curtis, Billy V. Lessley, and Richard E. Suttor.

Table 1. Potential effect of changes in processor profits on farm prices, 1964

Commodity	(A) Unit	(B) Farm price	(C) Pro- cessor resale price	(D) Processor profits		(F) Processor profits before taxes as per centage of farm price (D/I)	(G) Change in farm price due to change of one percentage point in processors' rate of return on equity after taxes		(I) Change in farm price if processors had earned the following rates of return on equity ^a					
				Before income taxes	Percentage of equity after income taxes		(D/E)	(G/B)	0%	5%	10%	15%		
			cents per unit		percent	percent	cents			percent				
Beef (choice)	1 lb.	46.2	51.5	0.4	9.0	0.865	0.044	0.096	+0.9	+0.4	-0.1	-0.6		
Broilers (ready to cook)	1 lb.	19.7	23.9	0.1	7.6	0.507	0.013	0.066	+0.5	+0.2	-0.2	-0.5		
Eggs (grade A)	1 doz.	23.1	36.3	1.0	12.2	6.622	0.081	0.542	+0.2	+3.9	+1.2	-1.5		
Fluid milk	1 gal.	29.1	40.4	0.1	13.0	4.403	0.004	0.100	+0.1	+1.0	+0.3	+1.4		
Processed fruits & vegetables	1 gal.	23.1	40.4	1.5	12.2	6.493	0.123	0.532	+6.5	+3.9	+1.2	-1.4		
Wheat (for bread)	market basket	2084.0	6508.0	88.0	6.7	4.226	13.134	0.630	+4.2	+1.1	-2.1	-5.2		
	1-lb. loaf	2.33	17.05	0.73	11.3	31.330	0.065	2.772	+31.3	+15.5	+3.6	-10.2		

^a This analysis assumes that short-run changes in a food-processing industry's profits are fully reflected in farm prices. It also makes the not too unrealistic assumption that the corporate income tax rate is the same for firms earning 5, 10, and 15 percent on equity.

Source: Margin data except profits as percent of equity are from the National Commission on Food Marketing [1]. Data on profits as a percentage of equity are from USDA data [2, p. 11] and from various commodity technical studies of the National Commission on Food Marketing.

has been calculated for seven types of commodities (beef, broilers, eggs, fluid milk, fruits and vegetables, and wheat)¹ as a share of the producer's price in 1964 (Column F, Table 1). Using these data as a base, we find that the change in farm prices due to a change of one percentage point in profits can be calculated where changes in profits are fully reflected in changes in farm prices and vice versa (Column G, Table 1). These data can in turn be used to calculate the effect on farm prices of other profit rates where changes in one are fully reflected in the other (Column I, Table 1).

The data show that profits as a share of producer's price in 1964 ranged from 0.5 percent (broilers) to 31.3 percent (wheat for bread) but that, of the seven commodities, only wheat for bread had profits greater than 6.6 percent. Thus, for six of the seven commodities, producers in 1964 could not, through bargaining, have increased their returns more than 6.6 percent from processor profits no matter how strongly they were organized.

Most farmer bargaining agencies,

¹ Bread baker-wholesalers are typically not first buyers of wheat from farmers. Farmers are thus not in position to bargain with them on price. They are included in this analysis to illustrate the high ratio of processor profit to farm value where the value added by the processors is high relative to the farm price for the raw material.

it seems reasonable to assume, would hope and expect processors of their products to earn some positive rate of return on their investment, both to be fair to the processors and to insure that processors would stay in business and remain progressive. If in 1964 there had existed all-powerful farmer bargaining agencies for each of the commodities studied here, and if they had allowed the processors of their products to earn a modest 10-percent return on equity, prices received by farmers producing for the various industries analyzed here would have changed in 1964 in approximately the following ways: beef, -0.1 percent; broilers, -0.2 percent; cheese, +1.2 percent; eggs, +0.6 percent; fluid milk, +1.2 percent; processed fruits and vegetables, -2.1 percent; and wheat for bread, +3.6 percent. It can be seen that for three of the seven commodities analyzed, farmers would have received less than they did and for only wheat for bread would they have received more than a 1.2-percent increase. Considering the cost of organizing and maintaining an agency for the purpose of bargaining away marketing margins, and realizing that it most likely would not be as powerful as the theoretical one assumed here, one might seriously question whether such an agency would be worth the effort.

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INVESTMENTS IN HUMAN CAPITAL FORMATION THROUGH TRANSFER PAYMENTS*

At one time it was meaningful, or so we thought, to distinguish between economic and welfare policy. Economic policy had to do with production in the broadest sense, welfare policy with distribution via the public sector, presumably as a result of human concern for the well-being of others. Today, on the contrary, public programs explicitly recognize that what is done on welfare programs has some potential bearing (in one direction or another) on labor productivity, and vice versa. Thus, "welfare programs" have come to be viewed, in part, as investments in developing the productive capacities of the recipients and their families, as well as tools for alleviating economic privation in the shorter term. In fact, from controversy of recent years over welfare programs, particularly Aid to Families with Dependent Children and Unemployed Parents (AFDC-UP), it may be inferred that some people think these investments have a negative marginal value product, that is, that they contribute negatively to the motivation for work and for upgrading of skills by personal investments of time, funds, or effort. But reliable evidence is scarce!

Whatever the merit of the allegations, evidence is needed regarding the effects of these programs on long-term productivity of the recipients,

and, more particularly, of their families. Because the programs involve transfer payments of one kind or another, it is evident that their contribution depends heavily upon what recipients do with their money and how the receipt and disposal of these monies affect related behavior that has a bearing on future productivity. This includes such things as aspiration levels, motivation for learning, and incentives for school attendance and achievement. This suggests an important and challenging new field for consumer economics research, that is, how recipients from different social classes respond to infusions of transfer payment income, and how their responses are conditioned by cultural and social characteristics, related institutions, and program structure.

The Work Experience and Training (W.E.T.) Program of the Office of Economic Opportunity provides some interesting innovations in welfare programs. At least as it has been administered in the state of Kentucky, it represents an attempt to improve the productivity and employability of "hard core" unemployed recipients and their families. This is done by a system of income "grants" coupled with requirements for earning the value of grants on public works projects or on private business projects in which the recipients have an opportunity to learn some useful skills.¹ The program

* The investigation reported in this article (No. 67-1-125) is in connection with a project of the Kentucky Agricultural Experiment Station and is published with approval of the director. However, views expressed do not necessarily reflect official views of the University of Kentucky.

¹ Levitan [6, pp. 74-75] has noted that, nationwide, relatively few were employed on projects in which useful skills could be learned. This was also true in eastern Kentucky, where industrial activity is extremely limited, except for mining, which has been declining for

additionally requires that children be enrolled and attend school regularly and that recipients lacking basic education attend school, usually six hours per week in the evening. Social workers provide guidance in family matters.

Is this a productive use of public funds? Does this infusion of income contribute negatively or positively to future productivity? Or must it be rationalized, if at all, purely on grounds of direct concern for the well-being of deprived fellow humans? In order to obtain evidence on these issues, a cross-sectional consumer expenditures study was conducted in 1966 covering 36 W.E.T. participants and 36 eligible applicants (excluded because of funds shortages) in three selected Appalachian counties of Kentucky, using a combination of respondent's recall of irregular or "lumpy" expenditures and a complete expenditure record for one month, October 1966.² The expenditure record was detailed enough

many years. Tax revenues available for financing suitable public works projects are also very restricted, and W.E.T. participants generally lacked adequate educational preparation. Therefore, the merit of such a program depends very heavily on its impact on the young, primarily through incentives for school attendance and changes in the social and physical environment of the home. (See also footnote 7.)

² Mean number of children, age of children, educational attainment, improved road mileage and unimproved road mileage to the county seat town were not significantly different in the two groups. There was a significant difference (six years) in average age, but regression analysis indicates that this difference resulted in underestimation of the response to free medical and dental service and of income elasticities of expenditure for the highest-priority categories of expenditure which are presented here.

to make possible many different classifications of expenditure.

The primary difficulty in this study was establishing a basis for classifying expenditures. The basis needed was one which would differentiate between those items with a high probability of contributing significantly to future productivity and those with a lower or zero probability of doing so.³ This difficulty is amplified by the fact that the social and economic characteristics of the area of residence heavily influence the appropriateness of any classification. An automobile, which is a luxury to an urban dweller with access to good public transportation, is a virtual prerequisite to employment, access to public services, and social intercourse with the broader community for people living in these small and often relatively isolated mountain valleys.⁴ A television set would seem, on the basis of available evidence on the cultural constraints to mobility and levels of aspiration in rural Appalachia, a probably beneficial family investment. It is one of the few avenues available in these

³ A precise basis of classification would require that both the probability that a specific experience would be relevant to the individual's productivity, and the magnitude of the effect of that expenditure on that experience, be taken into account. Our attempt to do this in our classification is reflected in the use of the word *significant*.

⁴ Both participants and applicants lived an average of nine miles from the county seat community where virtually all public services are dispensed, including benefits of the W.E.T. program itself. Most sources of nonfarm employment are well beyond walking distance, including W.E.T. employment. There is no local means of public transportation available except the occasional taxi in the county seat town.

communities for broadening cultural perspectives and social horizons.⁵

Lacking a concrete evidential basis for the classification, we used a judgmental classification. While tenuous, this at least provides some basis for assessments of program performance. In the highest-priority category (highest probability of contributing significantly) were the following items: automobiles (payments), house mortgage payments and home improvements, savings, life insurance, clothing, food stamps, cleaning supplies, and consumer durables (below established maxima designed to eliminate frivolous expenditures).⁶ Coffee,

⁵ The fact of cultural isolation is well documented by the studies of Harry Caudill [1], Jack Weller [9], and others. That it is connected with personality factors which have an adverse effect on productivity is strongly suggested by the work of R. B. Hughes, Jr. [3], and Eldon D. Smith [8]. We know of no specific studies of the effects of television, home improvements, and the like on rural Appalachian acculturation. Hughes's study demonstrates that both family and community wealth during childhood, presumably reflected in home and community environment, have positive effects on mobility, current incomes, and other factors held constant. Kindleberger [4], Nurske [7], Kuznets [5], and others have noted the international significance of Duesenberry's "demonstration effects," [2] which have been facilitated by improved communication. Almost all evidence suggests that television is a most powerful medium of mass communication.

⁶ Judgmental limits were established after consultations with program administrators, appliance dealers, and others. The criteria were minimum costs necessary to give serviceability without excessive maintenance costs. Values below these limits usually implied either purchase of "used" items or "economy" models. Limits were \$200 for refrigerators, \$200 for television sets, \$180 for kitchen stoves, \$200 for living room fur-

tea, cocoa, tobacco, candy and sweets, food in excess of food stamp allotments, and consumer durables in excess of established limits were included in the lowest-priority category (judged to have zero probability of contributing significantly). All other items occupied a middle category.

Income elasticities of expenditure for these broad categories were computed with cash incomes and expenditures of the applicants as bases, since the relevant concern was the effect of additional income on such families. The average income difference between applicants and participants was large proportionately, and the problem involved responses only to upward changes in income. Therefore, standard reversible arc elasticities were not used. The formula for the measure used is as follows:

$$\text{Income elasticity of expenditure} = [(E_p - E_a)/E_a]/[(I_p - I_a)/I_a]$$

where

E_p is expenditures of participants,

E_a is expenditures of applicants,

I_p is income of participants, and

I_a is income of applicants.

The results were elasticities of expenditure of 1.5, 0.6, and 0.4 for the high-, medium- and low-priority categories, respectively; average monthly cash incomes were about \$84 and \$220, respectively for applicants and participants.

niture, \$100 for kitchen furniture, \$100 for bedroom furniture, \$200 for washing machines, and \$200 for freezers. Medical and dental service, including medicine, was free for program participants and their families. School lunches and school supplies were often provided free to indigents, but most W.E.T. participants were required to pay for them. Therefore, these items were nondiscretionary and not included in the highest-priority class, even though as items of consumption they were of very high priority.

These findings would appear to cast doubt on the assumption that the poor in general or Appalachian mountain families in particular are impulsive spenders who lack the frugality or wisdom to manage money. Alternatively, it may suggest that the program was exceptionally well designed to redirect these behaviors. Monthly payments for durable goods in excess of established maxima averaged only \$1.56; only "used" automobiles were purchased; there were improved and generally good school enrollment and attendance records; participants made extensive use of free health services—all these findings lend support to the conclusion that recipients of benefits were both frugal and conscious of the implications for their future of what they did.

What is not known and cannot be known without comparable studies of other programs, preferably with more refined tools, is whether the participants were predisposed to this type of behavior or whether this program served to change otherwise inadequate behavior patterns into channels which hold out some hope of improving the productivity and earnings of recipients and their families. The hypothesis which turns out to be valid will have an important bearing on the

appropriateness of program structure and eligibility requirements of this and other programs relating to the poverty classes. Comparative studies are needed; and income elasticities of expenditure would seem to be relevant to such studies.

Although the techniques employed in this study were obviously crude, the study suggests such further research possibilities as (1) more precise identification of strategic lines of expenditure, (2) analytical assessments of the specific lines of expenditure which should be controlled administratively, and (3) the effects of control provisions on strategic areas of behavior such as school attendance and performance, mobility, and utilization of medical and dental services, and on other categories of expenditure (cross elasticities). Tools of consumer economics research combined with insights borrowed from our sister social disciplines have a potential for unraveling this important skein of issues relating to the development of human resources of poverty families in rural areas.

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Reviews are listed alphabetically by authors.

Reviews

Clawson, Marion, and Jack L. Knetsch, *Economics of Outdoor Recreation*, The Johns Hopkins Press for Resources for the Future, Inc., 1966, xx + 328 pp. (\$8.50)

Again the authors have provided a timely book in an emerging area of national interest—this time in outdoor recreation. Dr. Clawson and Dr. Knetsch have done an excellent job of summarizing research concerned with the economics of outdoor recreation and of providing a synthesis in a logical form.

The book is written so that it can be readily understood by individuals with a very limited background in economics. The authors undoubtedly chose this style because the people interested in recreation constitute an extremely heterogeneous group. Consequently, the book loses some of its value to the professional economist but probably will have a much greater overall impact on those concerned with outdoor recreation problems.

The book should represent a welcome addition to the literature by those teaching survey courses in outdoor recreation. In addition, it will serve as a very useful reference for undergraduate courses in the economics of outdoor recreation.

Although the authors have indicated that the emphasis of the book is placed upon the economic and social aspects of outdoor recreation, they have devoted most of the book to economic considerations. Approximately one-third of the book is devoted to the various aspects of the demand for outdoor recreation. They review the fundamentals of demand curves and the factors which have influenced the nature of these curves. The traditional approaches to estimating the demand for outdoor recreation have been reviewed, including a rather thorough discussion of their limitations. The lack of accurate data relating to all phases of outdoor recreation is emphasized throughout the book. The authors conclude on a rather pessimistic note: "The methodological problem is admittedly difficult, but a more basic difficulty is the nature of the demand for out-

door recreation. This is dynamic and changing; the future may be very different from the past, and we know relatively little about the past. No methodology can yield wholly satisfactory answers when the problem is so difficult and the data so poor" [p. 141]. Granted, the future may be different from the past; but is this problem more critical for recreation than for other new products for which there are few or no historical data? And if recreation is important, then sufficient resources should soon be available for improved data collection systems.

Problems concerning the pricing of and paying for outdoor recreation were considered at length. In the case of free facilities, it would have been enlightening if the authors had discussed in more detail the qualities of outdoor recreation as a method of income redistribution. With the increased awareness of social problems facing the nation, this question undoubtedly will become more and more important.

The economic impact of outdoor recreation on local economies is of utmost importance to many communities since it is often suggested as a source of economic stimulus. The authors wisely conclude that "it is important to recognize that there are problems connected with the recreation business itself and that the recreation business potential of an area is affected by specific characteristics of area, location, and economic structure, as well as other conditions" [p. 244]. However, they have not considered the impact of recreation developments upon the total integrated economy of a region; for example, a state or national park may not greatly affect the nearby local economy but may have tremendous economic effects on the home cities where the users purchase their equipment and other recreation supplies.

The authors point out that "recreation simply has not been recognized by many professions as a respectable field for scientific inquiry" [p. 293]. This attitude has tended to discourage recreation research. In conjunction with these views the authors have concluded "that outdoor recreation is not a separate field of human knowledge, but a kind of human activity. Many problems are related to this activity, and they can be studied in an organized way by applying the theory, logic, and methods of many of the established fields of special knowledge either singly or in combination. Outdoor recreation research has a unifying theme, a kind of activity, and a range of problems, but it is not a special field of knowledge as such" [p. 294]. The logic behind these remarks is sound and probably explains much of the confusion and lack of coordinated research in outdoor recreation. However, because of the public interest in outdoor recreation and the availability of government resources, there is a strong desire to identify outdoor recreation as a discipline.

The authors are to be complimented on the organization and scope of the book. It provides a very useful summary of research and problems in outdoor recreation.

IVAN W. SCHMEDEMANN AND
RAYMOND L. PREWETT
Texas A&M University

Dillon, John L., *The Analysis of Response in Crop and Livestock Production*, New York, Pergamon Press, 1968, xiii + 135 pp. (\$3.00 paper, \$4.50 cloth)

The book is intended to "help fill the gap in providing students of both agricultural science and economics with a simple but formal exposition of the why, how and wherefore of the principles of crop and livestock response analysis, thereby helping to further co-operative effort among biological and economic researchers" [p. x]. This is a recognition of the need for interdisciplinary cooperation in obtaining efficient use of agricultural resources, particularly in developing nations.

The theory of response is outlined in Chapter 1 under the limiting assumptions of diminishing returns to each input factor and decreasing returns to scale. The theory of response for one-factor and two-factor cases is developed and then generalized to n factors. The discussion focuses on physical implications of the theory.

Chapters 2 and 3 provide a normative analysis of response efficiency with emphasis on understanding the response process by controlling factor input levels. Chapter 2 abstracts from problems related to time and specifies the best operating conditions, both with and without constraints on the objective function. Time is explicitly introduced as a factor in Chapter 3 in analyzing time-dependent processes and time-preference effects.

Some important aspects of the problems associated with an empirical analysis of crop and livestock response are discussed in Chapter 4. Problem areas are identified as experimental design, statistical estimation, response variability over time and space, and discrepancies between results obtained under experimental and farm conditions. The discussion of these topics is admittedly brief, but they were selected for inclusion because of their significance in improving response research.

"As a primer on response analysis," theory and quantitative methods are stressed and integrated in a precise and consistent manner. Physical and economic concepts of the theory of response are presented in mathematical notation and graphic form, which will require an introduction to derivatives for students without a background course in calculus. Numerical examples, incorporating problems in crop and livestock production, are used to relate analytical principles and their use. A variety of algebraic forms are used in the numerical examples in the text and in exercises given at the end of each chapter. By combining several methods in presenting and illustrating concepts in a thought-provoking manner, Dillon helps the reader to gain important insights into response relationships.

A section on resource materials is presented in each chapter, with references to specific concepts and to empirical studies of crop and livestock response efficiency analysis. More importantly, the sections on further reading provide an evaluation of the scope, content, and/or empirical significance of selected contributions in theory and response studies. Areas for further analysis are identified.

Dillon has been selective by focusing exclusively on crop-fertilizer and livestock-feed response. This choice was deliberately made, since he acknowledges

in the preface "that crop and livestock response processes are generally embedded in larger response systems—both biological and economic—whose ramifications are not irrelevant." There is increasing interest in applying the analytical principles outlined in the book to a broad range of problems such as supply response, technological change, and investment programs. It would have been helpful if he had explicitly explained these relationships and pointed out the relevance of the principles to these broader problems.

The use of metric weights and measures may make an understanding of examples more difficult for the United States audience. The clarity of presentation and the author's efforts to communicate to both economists and researchers in biological sciences are helpful in making this a valuable reference. Further, the comprehensive treatment of analytical principles makes it a useful supplemental text in economic theory, mathematical economics, farm management, and related courses.

WILLIAM M. CROSSWHITE

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Food Research Institute Studies, *Proceedings of a Symposium on Price Effects of Speculation in Organized Commodity Markets*, Supplement to Vol. VII, Stanford University, 1967, 194 pp. (\$4.00)

A tendency nowadays is to belittle price-making markets in our advancing industrial state. But one hallmark of such markets, organized futures trading, has enjoyed a resurgence in recent years. This may not be widely known. Although the Stanford work does not chronicle such history, its appearance should give intimations of the capacity of price-making markets to organize economic activity. The main appeal, however, will be to the small but growing number of students of futures trading.

What is the economic role of the speculator in futures? Six economists, mostly seasoned specialists, were commissioned to write papers. A seminar was held to clarify and sharpen debate. General financial support came from the Chicago Board of Trade, the Farm Foundation, and the Minneapolis Grain Exchange. The result is a set of thoughtful papers.

Three different, but not mutually exclusive, theories were examined: (1) that speculators assume hedgers' price risks, for which they receive payment; (2) that speculators predict prices and that they profit by inducing a better allocation of stocks over the course of time; and (3) that speculators anticipate hedging needs and earn a margin for improving market liquidity.

The first theory has held a great fascination for economists, ever since the "inverted markets" of the early post-World War II period caused a rediscovery of Lord Keynes's views published in the early post-World War I period. Keynes had little regard for the ability of commodity speculators to forecast prices, but he found a useful role for them, nevertheless, in their acceptance of price risks. This continues to be the most popular explanation in textbooks and in the trade.

Most attempts to verify the theory turn on showing an underlying trend (bias) in futures prices over the life of futures contracts. Such trends are

needed for the persistent speculator to get a return if he has scant ability to predict prices.

Three papers are mostly devoted to examining the evidence for this view. Rockwell extends the coverage of an earlier study by Houthakker, by examining 25 markets for 18 years (instead of only 3 markets for 11 years). For the large markets, he infers that hedgers' losses became large speculators' profits. Small speculators made nominal profits. In small markets, large speculators profited at the expense of small speculators. Hedgers made nominal profits. Rockwell infers that none of the gains were due to existence of a bias in futures prices (because futures prices rose when speculators were net short but did not rise significantly when they were net long). Hence, he accepts the alternative view that all speculative profits were due to forecasting ability by a subset of speculators and that futures prices are unbiased estimates of the ultimate spot prices.

Telser's paper is a detailed study of wheat, corn, and soybean markets. Using somewhat different techniques, he confirms his findings of a decade earlier. Businessmen usually pay nothing for reducing risk by hedging. Speculators cannot count on profiting by simply holding long positions against hedge selling by inventory holders. Futures prices are unbiased predictors of subsequent spot prices.

Cootner's paper is mostly a discussion of research by Gray, Telser, and Cootner. Rockwell's research is not examined. Cootner alone is inclined to give credence to the risk-premium view—but he admits that it need not be a universal truth. A detailed discussion is given of why different researchers get conflicting results with the same data. He believes that "most of the controversy turns on different theories (usually implicit) rather than argument about the data" [p. 85].

This opinion contrasts sharply with Larson's view. Larson eschews usual methods for estimating profits of different classes of traders because of the extent of nonreporting, misclassifications of reported hedging, speculation and spreading, and no data on timing of transactions. Profits imputed to speculators can be traced to a few episodes of large price moves, or to persistent inflation, and not to the alleged sources of profits. (Larson has studied the data in the past and has tried to rectify major deficiencies.) Moreover, Larson believes that the usual methods impute a motive to speculators that begs the question of ability to predict prices.

He takes another approach. Where a repetitive cycle of prices exists, it should have been predictable. He asks, in the case of egg prices, whether futures speculators had anticipated the cycle in cash prices. He finds indications that they had.

Larson's identification of a 30-month price cycle for eggs is interesting in its own right. It follows his earlier study of "harmonic motion" in hog prices. In each, the duration of the cycle is four times the production period, not two times as implied by the cobweb theorem. This thesis deserves more attention than it has received so far.

The third theory of speculation is reflected in papers by Working and by Gray. It explains a special kind of speculation. Payment is made by hedgers to professional speculators who have developed the knack of buying on dips, sell-

ing on bulges, and otherwise keeping a fine ear tuned to profit opportunities within and between trading pits. Neither risk assumption nor price-level prediction explains such behavior. It is a payment extracted with much skill from hedgers, who have to pay it to get market liquidity. Working calls it the "execution cost" of hedging. Such speculators operate between hedgers and longer-term speculators.

Working, dean of scholars of futures trading, has studied many aspects of futures trading for four decades. We are indeed fortunate to have his matured views on the intricacies of the mechanism by which hedging attracts speculation. At some strategic points he reverses his earlier views. He throws into perspective the entire structure of trading, the basis of which is its organization into highly specialized enterprises.

Gray's paper follows his earlier interest in the relations among three wheat markets. He uses recently available break-outs of data to construct a model of spreading between Kansas City and Chicago wheat markets. The data are interpreted to show that the short hedging load at Kansas City is transferred to long speculators at Chicago through actions by professional spreaders who keep a keen eye on both markets. Such speculation comes into play only as needed.

My main reservation about the Stanford work pertains to much of futures trading literature. Research tends to be shaped too far by the data generated by futures transactions. Although this often cannot be helped, the research results are purchased at a price. Like the iceberg that shows only its top, organized futures trading is but the most obvious part of the larger body of exchange relationships in commodity markets. Hence, one cannot be sure of his perspectives on many of the topics.

This point may have been on Telser's mind when he argued, at the close of his paper, for more information on forward trading in cash markets, and for direct evidence of profitability of futures trading by speculators. This list should be extended to include information on such things as traders' income levels, portfolio composition, and income tax liabilities. Each has a bearing on trading behavior and each should be considered in the context of all relevant institutional features of commodity markets, in order to judge market results. Recognition of the wider scope of the questions being raised conceivably could lead to the relevant data.

ALLEN B. PAUL
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Freeman, Orville L., *World Without Hunger*, New York, Frederick A. Praeger, Publishers, 1968, xv + 190 pp. (\$5.95)

The book deals with the most important problem facing mankind in the twentieth century. The battle to win the war against hunger and starvation in the long run easily overshadows all the struggles and anguish of the man-made wars. Millions not thousands of human lives are at stake.

Secretary Freeman has chronicled the major contributions of the United

States in the fight to create a world without hunger. The stage is set by a brief résumé of the problems involving population and food supply. He succinctly states the issue when he says, "The difference between two children and six in a family may well determine whether we will live in a world of healthy, educated, productive people or one of widespread starvation and human degradation" [pp. 10-11].

The longest chapter in the book, Chapter 2, concerns itself with America's role in helping to meet world food needs. Food is a major asset of American foreign policy. This obtained under the Marshall Plan and the Point Four Program and will continue to hold true, Secretary Freeman asserts. He discusses in some detail how the Agricultural Trade Development and Assistance Act of 1954 (Public Law 480) has implemented U. S. international policy.

The difficulties of agricultural development in underdeveloped countries are reviewed and the requirements for increased food production enumerated. Special consideration is given to irrigation, reclamation, fertilization, genetics, and marketing reform. The economic analysis of capital investments by government and the private sector is the conventional one. However, author Freeman rightly emphasizes that agricultural output in developing countries has lagged because those countries and American governmental assistance agencies have themselves failed to give food production the capital priority required for rapidly increasing output.

The contributions of the Rockefeller and Ford foundations, together with those of a number of religious and voluntary agencies, are briefly discussed. Chapter 8 is a review of American participation in international cooperation via FAO, UNICEF, WHO (World Health Organization), OAS (Organization of American States), and numerous other organizations.

The food problems of India receive special attention in Chapter 9. Secretary Freeman stresses the changing attitude of the Indian government with respect to both positive action for population control and giving highest priority to agricultural development. Great hope is held that with continued capital and technical assistance India may finally become self-sufficient.

Chapter 10 is a statement of faith that P. L. 480 and the Food and Agricultural Act of 1965 will provide the basis for the United States to make effective use of our agricultural potential. "I have complete confidence," says the author, ". . . that we now have the tools that, if skillfully used, will make it possible to balance supply and demand" [pp. 173-174]. Although such faith and confidence are necessary to the conduct of a successful program, they are not analytically very useful.

Looking to the future, Secretary Freeman has four suggestions. (1) Establish long-range nutrition goals with emphasis on adequate diets for infants and pre-school children. (2) Allocate, each year for the next ten years, 1.5 percent of our national income to development in underdeveloped countries, with emphasis on food production. (3) Establish a quasi-public corporation for making development investments in developing countries. (4) Train at public expense volunteers who agree to serve in agricultural development overseas.

Secretary Freeman is to be commended for hitting hard at two fundamental

errors often expressed by world leaders: namely, that population growth can proceed unchecked and that the United States can feed the undernourished and starving people in the developing nations. But there are many necessary positive social and political requirements to build a world without hunger which go beyond population control and the provision of modern inputs. Developing countries must resolve the conflict between cheap food for urban consumers and adequate incentives for all-out food production. Social equity and maximum food production are seldom complementary goals. The desire to save foreign exchange while holding currency at inflated exchange rates is not conducive to increasing the supply of needed farm inputs. Modernization of agriculture for maximum food production is seldom compatible with the preservation of rural communities and rural full employment. The definitive word has not yet been written on the conflict between U. S. domestic agricultural policy and commercial exports and imports and their relationship to world hunger. All the foregoing conflicts and many more must be resolved at the political level. And we badly need the advice and insights of men with political experience to assist in their solution. A world without hunger is but a hope unless such political issues are quickly resolved. Adequate quantities of modern inputs are not a sufficient condition.

The book provides a short history of the U. S. contribution toward solving the world food problem. Laymen in many walks of life should definitely familiarize themselves with its contents. It might ever be required reading for students in arts and science as well as agriculture. It is not a requirement in the personal library of the professional agricultural economist.

STANLEY K. SEAVER
University of Connecticut

Hildreth, R. J., ed., *Readings in Agricultural Policy*, Lincoln, University of Nebraska Press, 1968, xv + 463 pp. (\$3.95 paper, \$6.95 cloth)

Hildreth has brought together 44 writings by 36 eminent authors on various aspects of agricultural policy. The articles were selected from the proceedings of the National Agricultural Policy conferences. Because of the audience for which the original papers were prepared, the volume is intended to facilitate the process of policy education.

The book is divided into five sections. Section I, "The Political Environment of Public Problems and Policies," contains articles primarily by authors who are political scientists. The articles are descriptive in nature and adequately discuss the nature of the political processes of policy formation. Unfortunately, the chapters tend to overlap and repeat each other, but such is to be expected in a volume of this nature.

Section II, "Price and Income Problems and Policies," sets the farm problem(s) in the context of agricultural economics. In addition to Brewster's eloquent discussion of the role of beliefs and values in affecting policy formation, other readings set forth the framework of the farm problem and criteria for

analysis of policy proposals. Other chapters deal with specific policy alternatives and special problems of agriculture.

In Section III, "Foreign Trade Problems and Aid Problems and Policies" are viewed. The articles are descriptive, with a minimum of evaluation.

Section IV relates to "Public Investment in Education." The hypotheses about the high potential productivity of public investments in rural education are offered and these hypotheses are supported with some evidence to substantiate their validity.

In the final portion, Section V, "Economic Growth and Investment" are discussed. The articles describe the various aspects of economic growth, the policy tools (monetary and fiscal policies) to promote growth, and other issues important to facilitating economic growth. The section is disappointing in two respects. (1) The articles describing the process of economic growth and policy alternatives to encourage this growth have little to say about the distribution of income. Although increases in per capita income or in GNP per capita are important criteria for growth, a volume devoted to agricultural policy should more explicitly confront the income distribution aspects of growth. (2) The articles tend to discuss economic growth in general, and the implications for agricultural policy are left to the reader. In that the book ends with three articles on the importance of and need for training and educational programs, one is left to infer that these are the only relevant policies for the agricultural sector that tend to promote economic growth.

The volume is impressive in its breadth, yet there are some weaknesses that should be noted. The "Price and Income Policies" section could have been strengthened by the inclusion of an article explicitly defining the farm problems. Only passing reference is made to the distinction between the problems of commercial agriculture and those of low-income farms. The full implications of large numbers of producers producing a homogeneous product, the inelasticity of demand with respect to price and income, and the growing importance of purchased inputs as compared with that of nonpurchased inputs are not adequately discussed. Similarly, not enough is said to enable the reader to evaluate the potentials of the various demand expansion programs. An article tracing the historical development of government in agriculture would tend to place the current policy alternatives in their proper perspective.

Little is said about resource development policies, particularly those relating to rural area development. Of particular importance to certain regions are problems relating to the water resource: its allocation and its conservation.

Literature is available that is devoted to the areas that are omitted in this volume. Because of this, the deletions are not serious. However, one would like to see a readings book as comprehensive as possible.

Although the book is intended to serve those involved with extension education, others will find it beneficial. Many of the articles would serve as useful material for undergraduate courses in agricultural policy. Further, agricultural economists will find the book a valuable addition to their libraries for quick reference to excellent descriptions of particular policies and programs.

MELVIN D. SKOLD
Colorado State University

Hirschman, Albert O., *Development Projects Observed*, Washington, D.C., The Brookings Institution, 1967, xiv + 197 pp. (\$2.25 paper, \$6.00 cloth)

Professor Hirschman continues his exploration into the process of economic development. This time his point of departure is not the "big issues" of inflation, balance of payments, land reform, or regional development (see his *Journeys Toward Progress*), but eleven World Bank-supported projects. He views this study as a complement and correction to and an elaboration of his earlier efforts. He spent most of a year visiting and analyzing projects selected to show a diversity of circumstances and achievement. Four projects were agricultural, two transport, two power, and one communications; one was a river valley development and one a pulp and paper mill. Four were in Latin America, three in Asia, three in Africa, and one in Europe.

The book is by no means simply a review of projects studied. Hirschman uses the project experiences as evidence supporting his case for a new attitude toward project design and evaluation.

Hirschman, win or lose, enjoys the word game, in which the conventional is cast in a new perspective by giving it a provocative name. The "Hiding Hand" explains why projects are initiated in spite of the innumerable reasons for not starting them. Outside influences on project success become "Uncertainties." Influences somehow controllable from within the project become "Latitudes and Disciplines." The dilemma of project design is the conflict between "Trait-taking and Trait-making." Project appraisal problems are covered in the "Centrality of Side-Effects." Earlier readers will remember the author's characterization of the establishment gradualists in Latin America as "reformmongers."

Some will be disturbed that project "success" is not defined in any clear-cut way. Nowhere does he equate success with a high rate of return to capital, or fidelity in loan repayments, or large contributions to GNP, even though in some passages one might interpret success as overcoming unforeseen problems. On more careful reading, we can see that the author's nonspecificity is deliberate. It is, in fact, at the core of his argument. The reasoning might be synthesized like this:

Developing countries, by their nature, are suffering from "lacks"—in capital, in skills, in institutions for mediating social conflicts. A project will make little or no contribution to the development of the society unless it aims to remedy some of these lacks. An overly ambitious project will, on the other hand, waste a precious opportunity and prejudice future efforts.¹ Designers of projects must decide which lacks, deficiencies, or "situational traits" to accept as given and unmodifiable, and which to overcome or modify in the process of executing the project. The most worthwhile projects can be brought off only where the designers frankly plan to change the social and institutional environment, for ex-

¹ A further dilemma, unexplored by Hirschman, is that those projects which most excite commercial investors are precisely those which least remedy such lacks. Preference is given to enclave-type investments which are most insulated from goings-on in the rest of the society, for example, a remote plantation or a tourist hotel. Private investment which does nothing to overcome structural deficiencies deprives the community of the chance to do so.

ample, through creation of new skills, or through training land-reform technicians. Almost by definition, then, an important development project will not reach its economic or production objectives without concomitantly modifying certain situational traits. "Some of the so-called side-effects thus turn out, a bit surprisingly, to be *inputs essential to the realization of the project's principal effect and purpose*" [p. 161].

In his fashion, Hirschman is explaining to the planners, the technicians, the accountants why their supposedly "sound" projects fail, or even when they don't fail, why they make so little contribution to development. His discussions on this point are stimulating and, to me, persuasive.

One would expect Hirschman to advocate strongly that side-effects be included side by side with internal rate of return to capital, when the projects are reviewed by the inevitable high-level decision makers. But his argument is not categorical. As good project designers and analysts, he argues, we must recognize and seek ways of achieving the desired side-effects. But the decision to include or exclude them in a project presentation ought to be based on the project designers' judgment of what the politicians are going to accept. Do we believe that the "trait-making" (for example, creation of entrepreneurial capacity among peasants) can and *will* be achieved in the absence of the project? If so, the particular side-effect should probably not be mentioned. If we believe that the trait-making through side-effects cannot be done without the project, we may still choose not to call attention to it if we fear that politicians will react negatively, in such a way as to kill or corrupt the project.

In deciding what weight to place on his observations and speculations regarding specific projects, we must consider Hirschman's history as a prognosticator. The evidence is that he is an unregenerate optimist. Great expectations for Colombian land reform and regional development in Northeast Brazil, expressed in his earlier works, have since proved excessive. Peru's San Lorenzo irrigation scheme and Uruguay's livestock production projects, both seen as well along the road to success in the present study, have suffered severe setbacks in more recent times and are both at a virtual standstill. Some discount seems called for, therefore, to balance his cheery views.

My principal complaint is with Hirschman's implicit theories of the political process and politicians. As one illustration, there is his amusing figure of the "Hiding Hand." Projects are initiated and vested interests are created to press for project completion because men cannot foresee all the difficulties which a project will run into. (Various students have noted an incurable tendency to overstate benefits and understate costs in project presentations [J. M. Healy, "Errors in Project Cost Estimates," *Indian Econ.* 12:44-52, July-Sept. 1964].) And, Hirschman argues, it is fortunate that the "Hiding Hand" limits our foreknowledge of difficulties since this limitation partly compensates for man's tendency to underrate his creative problem-solving capacity. The experience gained in facing and overcoming serious challenges may, in fact, be the most important benefit of the project.

In spite of its undoubted insight into selected situations, the Hand indeed Hides something: who really determines that a project will be considered and initiated? Projects that have gone through the World Bank procedures ob-

viously (and admittedly) are a very special breed. By looking solely at this group of investments, one gains the impression that economic and development-oriented criteria are very relevant, indeed the most relevant, in determining which projects receive attention and in what form. As any official in our Departments of Defense, Agriculture, State, etc., can testify, little government expenditure or investment is made in this way. Politically powerful groups in a society gain what they want or by definition they are not powerful. Hirschman handles this issue in too casual a way.

In other passages, Hirschman indicates that politicians are too weak to prevent unwanted projects from being initiated (the Hiding Hand), too dumb to prevent unwanted side-effects from being smuggled in, and so corrupt that they would capture any project which is not technical or site-bound enough. Whenever a devil or idiot is needed, Hirschman (like most economists) simply evokes the politician. When studies are made of the political processes by which projects get life, it is doubtful that economists should lead them.

The book would be much more useful if it contained an appendix summarizing the principal attributes and performance characteristics of the projects studied. Observations and insights lose their effectiveness when we do not have more than the author's assertion to hold to.

ARTHUR L. DOMIKE
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Mikesell, Raymond F., *The Economics of Foreign Aid*, Chicago, Aldine Publishing Company, 1968, 300 pp. (\$7.95)

This book presents a detailed review of the various theoretical approaches that have been developed to explain growth and development, and a critical appraisal of the uses of theoretical models by administrators of aid agencies.

The first chapter discusses the objectives of aid from the point of view of both donors and recipients. The author follows this with a review of various growth theories and their relevance in terms of foreign aid models. The development theories discussed, which are considered to have had a great impact on foreign aid policy and administration, are "(a) the critical rate of growth or minimum effort thesis; (b) the balanced growth or 'big push' thesis; (c) the absorption of surplus labor approach; (d) theories emphasizing external trade and capital imports; and (e) theories of investment criteria" [p. 46].

The author also discusses three basic approaches to foreign aid requirements by both theorists and administrators. These include "(1) the savings-investment gap approach; (2) foreign-exchange earnings-expenditure gap approach and (3) the capital-absorption approach" [p. 71]. This is followed by a discussion of the types and terms of aid and the implications of each for development. Chapter 8 includes a discussion of the burden of aid on the donor and how this burden should be distributed. The final chapter summarizes the author's conclusions relative to aid policy.

The author is highly critical of theories and models developed to date and especially their relevance and use in making policy with respect to aid. He

credits the models with having merit in providing indications of what might happen under certain restrictive conditions. However, he argues that there are too many important nonquantifiable factors to be able to develop any really meaningful general theories or models for development. He also feels that, in general, estimated parameters tend to be too unstable to be valuable. Mikesell feels that these limitations have not been given sufficient consideration and that aid administrators and policy makers have assumed too much in their application of models for policy-making decisions.

I would agree with the author that we are lacking in a satisfactory rationale for development assistance, which has contributed to the present rather general disillusionment with respect to aid, by both donors and recipients. As a result, there have been aid cuts when the needs seem to be more urgent than ever, and recipients are anxiously looking for new solutions to this dilemma. I felt somewhat let down, however, by the lack of concrete suggestions from the author. In fact, my first impression was to throw up my hands and retitl the whole subject "*The Uneconomics of Foreign Aid.*"

There is considerable evidence, both in this book and elsewhere, that we must break down some interdisciplinary barriers if we are to succeed in developing meaningful approaches to aid. The economic problems are heavily interlinked with social and political problems. A much greater effort must be made to develop simultaneous solutions to these problems if the criticisms raised by Mikesell and others of economic policies for developing countries are to be resolved.

In spite of the lack of concrete solutions, Mikesell does a fine job of reviewing various theories and policies in economic development. He points out the weaknesses in various approaches and demonstrates well the position of the debate at the professional and administrative level. Mikesell argues that there is not, and likely will not be, a theory or model to describe development in general and that there is neither a means of determining the amounts of aid necessary nor a method of distributing the burden equitably.

The author maintains that aid should be used mainly to mobilize the resources of the recipient. Aid should supply resources where necessary to overcome strategic shortages and to raise the capital absorptive capacity of the recipient. Emphasis should be placed on development of export potential and aid should not be given for uneconomic import-substituting industries that will need indefinite protection. Less emphasis should be placed on debt repayment, except for loan servicing. Capital repayment is considered both unnecessary and unrealistic.

The book suggests that the best method of providing aid is through multilateral agencies. Concessionary aid would be financed by a system of paid-in subscriptions of noninterest capital by donor countries. Hard loan capital would be obtained in a similar manner, but the administering agency would be authorized to declare dividends as returns on these funds. Mikesell concludes, however, that aid will likely continue to be given on a bilateral basis with numerous administrative organs, but he recommends more coordination of effort to obtain greater efficiency in the use of aid resources.

In my opinion this book is a valuable reference on the subject of develop-

ment. Important questions are raised and issues discussed which should help to guide administrators and policy makers in developing more meaningful direction to aid activities. The book should also provide a useful and thought-provoking reference for teaching, especially in graduate seminars.

ELMER L. MENZIE

The University of Arizona

Padberg, Daniel I., *Economics of Food Retailing*, Ithaca, Cornell University Press, 1968, xi + 292 pp. (\$8.95)

This volume represents an effort to explore the food retailing industry within the economic criteria of (1) structure, (2) conduct, and (3) performance. This work is largely documented from the data compiled by the National Commission on Food Marketing, which Dr. Padberg served as retail project leader. The author provides considerable depth for his discussion via tables, charts, and graphs drawn from the study, and achieves his stated objective of "reaching logical conclusions from the available data." The appendix, by way of example, includes two Federal Trade Commission antitrust cases. The volume has been read by a number of industry leaders and promises to be a valuable resource text. It has also been adopted for The Food Distribution Home Study Program, sponsored by the National Association of Food Chains and Cornell University.

The text is presented in four sections: Part I, "Organization of the Food Retailing Industry," Part II, "Competitive Behavior of Food Retailers," Part III, "Performance of the Food Retailing Industry," and Part IV, "Conclusions."

In Part I, the author introduces the topic with a well-documented description of "the status" of the *market structure* of the food retailing and wholesaling industry. Without resorting to the drudgery of a historical review, the text provides an interesting treatment for an otherwise burdensome volume of concentration ratios, integration and merger trends, brand "battles," and other measurable market structure changes from the 1930's through the 1960's. His knowledgeable discussion of the voluntary group movement suggests that the "little" independent has matured to a very formidable position in the industry.

Part II of the text treats the second criterion of the market economy, *the conduct of the market*. Under the title of "Competitive Behavior of Food Retailers," the author discusses price and nonprice competition, specials, and the effects of local concentration. A thorough discussion of trading stamps, from the vantage point of several independent studies, provides an excellent treatment of this one example of nonprice competition.

Part III is a well-balanced discussion of *market performance*. Dr. Padberg describes differences in gross margins, costs, and nets, as related to innovations, income areas, and types of firms. His evaluation of the differences in competitive advantage for chains and for affiliated and unaffiliated independents is especially helpful.

Concise conclusions (13 pages) are offered as Part IV of the volume. Here, Dr. Padberg addresses his comments to three ambitious social questions:

(1) "Is competition effective in utilizing the capability of private firms for the public well-being?"

(2) "Do monopolistic elements allow excessive profit rates?"

(3) "Do competitive conditions encourage unnecessary costs or services?"

His conclusion for questions one and two suggests that retail competition is an effective force limiting the self-interest motive of private retail food firms and that retailing competition also tends to absorb and dissipate any gains resulting from wholesaling market power. His statements applaud the competitive balance achieved through the market economy.

In reference to question three, Dr. Padberg suggests that the various "types" of retail firms, ranging from "mom and pop" stores to supermarkets and discounters, provide ample opportunity for the forces of consumer sovereignty to function. He therefore defends the higher costs of providing the "package" of consumer goods and services and suggests that the costs are not unnecessary.

This volume is an excellent interpretative statement of the earlier Food Commission work and gives a valuable insight into the action-reaction drama of the dynamic food industry. It will be a useful resource text for colleges and universities and for food industry management training programs.

There are three general concepts alluded to throughout the text, however, that would profit by an expanded treatment by the author, perhaps in a subsequent volume. These include (1) an analysis of the relevant theory, (2) other forms of nonprice competition, and (3) federal merger policies.

Reference is made to perfect competition, the atomistic structure of the food industry, and the limitations of economic theory and economic reality. Although these considerations are of some consequence, the theoretical models of oligopoly and monopolistic competition are more representative of the food industry and would provide a more meaningful comparison of market power. The relevant market and the appeal to a specific stratum of that market by a segment of the industry, such as the discounter, the convenience operator, and the supermarket, could provide a more valid basis for evaluating market behavior. For example, the relevant market in the Procter & Gamble-Purex Case was considered to be 20 feet of grocery gondola, whereas the relevant market for National Tea, Budweiser, and other firms was considered to be a vast geographic area. There are, in effect, as many oligopolistic "firms" within the cleansing-product section of the grocery department as there are in a metropolitan market. A comparative analysis of theory and reality on this basis would likely generate some interesting contrasts.

Dr. Padberg should also be encouraged to expand his analysis of nonprice competition in some future volume. His study of stamp costs (which he readily suggests as only one example of nonprice competition) would provide helpful insight into a similar treatment of the full spectrum of promotional and customer service costs. This would suggest a more complete comparison of other nonprice strategies, such as remodeling costs, check-out expeditors, store hostess service, and double-bag and carry-out services. It is conceivable that a given firm may incur an even greater expense to maintain "the carnival atmosphere" or even the image of "the friendliest store in town" than that incurred by a stamp-giving or price-merchandising competitor. This suggests a cost-benefit

comparison between stamps and the extra labor (approximately 1 to 2 percent) expended by many firms to maintain a "Hi Neighbor" atmosphere through store hostesses and superior check-out service. To state that the cost of a promotion, such as stamps, requires a 40-percent increase in store volume suggests that costs and profits are linear, when they are, in fact, nonlinear, especially beyond the break-even point.

A third volume was suggested by Dr. Padberg's concluding paragraphs, citing inconsistencies in federal merger policies and pointing to high private and public costs resulting from divestitures. This topic would merit a more detailed consideration in a subsequent publication.

Dr. Padberg's chief contribution with this volume is providing a well-documented interpretative analysis of the competitive aspects of the food industry. I recommend the text as an excellent reference for economists interested in an overview of "economics in action" in the food industry setting.

S. E. TRIEB

Kansas State University

Pincus, John A., ed., *Reshaping the World Economy: Rich Countries and Poor*, Englewood Cliffs, New Jersey, Prentice-Hall, Inc., 1968, xii + 176 pp. (\$4.95)

The purpose of this book is to provide an introduction to the role of the world economy in the economic development of the poor nations. The book consists of an introduction by the editor and a collection of fourteen previously published articles and report summaries by economists and groups of experts. The introduction by the editor provides a summary of a series of economic relationships between rich and poor nations and outlines major policy issues facing the two groups of countries. In this way the editor provides the structure for the book and a framework which relates the issues and policies discussed in the readings.

The first group of articles examines the world food and population problem, explores the growing income disparity among nations, and briefly discusses the characteristics of the less-developed countries. The following two sections consider the two major sources of external resources available to less-developed countries: (1) government transfers (foreign aid), and (2) world markets (foreign trade and private capital flows).

The final section of the book examines the view that special provisions and arrangements will be required to enable the poor nations to operate effectively in the world economy and to benefit from this participation. The special provisions and considerations which are discussed include (a) trade preferences, (b) commodity agreements, (c) economic integration, and (d) supplementary finance schemes. In addition, there is also an article on the Horwitz proposal to increase the flow of capital to poor nations.

In selecting the readings, Pincus has attempted to present divergent points of view on the major issues; however, authors and articles of equal persuasiveness

are not always available. The authors of the two articles on foreign aid, Friedman and Wolf, effectively draw out the relevant theoretical arguments and policy issues. Harry Johnson does the same in his excellent article on trade preferences. However, a critical evaluation of economic integration among less-developed nations is lacking, and the Horwitz proposal is left unchallenged, both conceptually and as regards alternatives. The volume would also have been strengthened by the inclusion of a discussion of the impact of the proposed changes in the world monetary system on less-developed nations.

In general, the book meets its major objective and deserves high marks in terms both of the completeness of coverage given to the topic and selection of the articles. Although the book contains no new material, it will be useful as a source of supplemental readings in courses concerned with economic development and international understanding.

WAYNE A. SCHUTJER

The Pennsylvania State University

Sahota, Gian S., *Fertilizer in Economic Development*, New York, Frederick A. Praeger, Publishers, 1968, xxii + 240 pp. (\$15.00)

Moore, John R., and Frank A. Padovan, *U.S. Investment in Latin American Food Processing*, New York, Frederick A. Praeger, Publishers, 1967, xiii + 208 pp. (\$15.00)

The reader of *Fertilizer in Economic Development* might reasonably expect to find an analysis of the role of fertilizer in agricultural production of the developing countries. The book is one of a series of Praeger Special Studies in International Economics and Development. In the Foreword, T. W. Schultz suggests that it provides basic information for those planning economic development. In his Preface, the author tries nobly to place his study in the economic development context. The reader who is expecting such a discussion is in for a surprise.

The subject matter of the book is price analysis applied to the U.S. fertilizer industry, not international economics and development in the conventional sense. It expands on earlier prices work by Griliches in presenting the results of a multicorrelation analysis of selected factors affecting the long-run decline in the relative price of fertilizer in the United States. The independent variables were (1) input prices, (2) productivity, and (3) competition. These variables explained 34 to 49 percent of the decline in the relative price of fertilizer from 1936 to 1960. On the basis of the upper estimate, increased industrial productivity explained 27 percent, increased competition 12 percent, and lower input prices 10 percent. The nitrogen industry accounted for most of these price-reducing effects, with 15 to 30 percent. Increased productivity in the distribution of fertilizers accounted for another 13 percent.

These findings contribute to the field of industrial organization analysis. The concept of "relative price" represents a unique tool in the study of industrial performance, which is of relevance in an inflationary era. The author's approach

may be particularly useful to an agency such as the President's Cabinet Committee on Price Stability, enabling it to separate out the roles of productivity, factor costs, and competition. If the book carried a proper title, industrial organization economists would more easily discover its unique contributions to the field.

It must be granted that the book presents the problem of fertilizer pricing in developing countries. Although the relative price of fertilizer has been declining steadily in the United States, Europe, and Japan, it has remained high in the developing countries that need it most. Competition in the United States forced the nitrogen fertilizer industry to pass on to farmers some part of the benefits from technological change. Why not in the developing countries? The author is silent on this point. He does not relate his findings to conditions that affect fertilizer prices in developing countries.

An alternative approach would be to project technological and user-preference data, and then to analyze the kinds of plants, firms, institutions, and marketing channels that should emerge in the developing countries. For example, a recent preliminary report by the Brookings Institution on nitrogen fertilizer production in Latin America suggests that nitrogen fertilizer costs run about 15 percent higher than they would under an optimum system. Moreover, in 1965 the costs of importing nitrogen fertilizer from the United States were about 50 percent higher than they would have been under an optimum system in Latin America. Thus, although Sahota demonstrates a 52-percent decline in the relative price of U.S. fertilizer since 1936, the domestic industry cannot be held up to the developing nations as a model for economic development of an optimum system without important qualifications.

The contribution of the Moore and Padovan book is that it yields hypotheses regarding kinds of firms, institutions, and marketing channels that should emerge in developing countries. *U.S. Investment in Latin American Food Processing* presents a summary of the institutional barriers to development in 11 Latin American countries. Many of the environmental problems discussed are applicable to fertilizer as well as food processing. For each country, the authors include a short summary of the geography, population, general economy, agricultural sector, politics, food processing investment, government programs, and production and marketing costs.

They conclude that the most important barriers to investment are (1) the extent of the market—that is, the number of buyers in the market economy, their purchasing power, competition locally and from abroad, and the ability to stimulate product demand and to develop sales channels and organizations; (2) government-related uncertainties, such as inflation, taxes, profit remittance, trade restrictions, expropriation, price control, irresponsible labor agitation, and inadequate police protection; and (3) production factors, including technology, credit, capital, raw materials, transportation, labor, and management.

It is a useful book for potential investors if they have little knowledge of the important factors influencing development in the countries discussed. It is not meant to serve as a substitute for a detailed engineering and economic feasibility study. The authors rely on interviews with food processors and government officials and summarize opinions regarding each barrier. The book contains little

or no data to back up the conclusions regarding most of the barriers to economic development. The task remains to test the strength of each barrier for particular industries in agribusiness, perhaps using the multi-industry framework of Bain's work on barriers to entry.

RICHARD G. WALSH
Colorado State University

Schmid, A. Allan, *Converting Land from Rural to Urban Uses*, Baltimore, The Johns Hopkins Press for Resources for the Future, Inc., xiii + 103 pp. (\$4.00)

Professor Schmid's book leads the reader from smile to frown and then back to smile. The first smile comes on the unexpected discovery that the preface was written by Marion Clawson. Reading the preface continues the smile. Chapter I, the introduction, goes well, but by the time the reader is well into Chapter II he finds himself wishing that much of it had been made an appendix so that the thread of the message would be a little less strained. But from then on, the smile begins to return, and Dr. Schmid's monograph flows well and relevantly.

The readability of the book will be improved by reading Chapter IV, "Conclusions and Policy Implications," and then proceeding through the book in normal sequence, including, perhaps, a rereading of the six-page Chapter IV and then on through the nine very interesting appendix tables.

Dr. Schmid's book will become standard reading for those interested in the urbanization of land, and it will be a long time before the research leads it suggests have been exhausted. Although no theoretical breakthroughs are evident, much relevant theory is laid out clearly, and this will make the work of others easier. Just the bibliographical footnotes (which are at the bottom of the page where they *ought* to be) will provide a wealth of information to those who wish to become more familiar with a range of literature which agricultural economists don't normally stumble across.

The main emphasis of the monograph, Dr. Schmid correctly stated, was "to call attention to the appreciation in lot prices above costs as a subject for inquiry" [p. 53]. This he did by developing estimates which suggest many instances of "unearned increment." You keep expecting Henry George to leap out at you, but he doesn't even make the scene until page 34 and then it is little more than a whisper from the wings. Professor Schmid tries hard to offer no doctrinaire solution and insists that his real concern with the distribution of rents "is not one of equity alone, but of what kinds of products result" [p. 57].

In this book, Dr. Schmid shows himself an institutionalist, who thinks that important questions should be democratically decided on the basis of adequate analytical concepts and sufficient relevant data. He makes the case well that land use policy on the fringe is too important to be allowed to grow like Topsy.

It might be possible to summarize the book further, but I will resist the temptation. I read the book to write a review and now I only want to write a

teaser to make others read it. *Converting Land from Rural to Urban Uses*, though misleading in its title because it deals primarily with appreciation of home building lots in subdivisions and not with the range of concern implied by the title, deserves reading by all interested in the economics of urbanization, and who among us can afford to be uninterested?

ROBERT J. BEVINS
University of Missouri

Smith, T. Lynn, *Colombia: Social Structure and the Process of Development*, Gainesville, University of Florida Press, 1967, xv + 389 pp. (\$12.50)

Economists maintain that the land tenure system in Latin America, characterized by the *latifundio-minifundia* syndrome, dampens incentives to produce and is inimical to long-term investments which bear importantly on farm productivity. Sociologists point out that the same system produces social stratification and inhibits vertical social mobility. These generalizations are not always easy to substantiate, but this volume by T. Lynn Smith provides new and convincing evidence to support both the economists' and sociologists' views. This book contains not only a substantial amount of data but also fresh analyses and interpretations which clearly reflect the experience of the author, who has spent almost a quarter of a century studying, writing, and working directly with the problems found in Colombia's rural areas.

Professor Smith draws primarily on the 1960 census of agriculture (which was not compiled in usable form until 1964) to demonstrate once again what many experienced observers have long maintained: for example, that land ownership is highly concentrated in rural areas of Colombia. Consequently, the distribution of wealth and economic opportunity, which are associated with land ownership, is highly uneven.

The official data showed that 1.7 percent of all producers control 55 percent of the land, whereas on the other end of the continuum 63 percent of the producers control only 4 percent of it. These data do not take into account producers who control more than one farm unit, but Dr. Smith has reason to believe that there are many such producers, particularly those who control more than one large estate. After providing detailed information on land holdings, Dr. Smith presents some interesting correlatives which show such characteristics as hectares of various crops planted, head of livestock, dwellings, and farm machinery according to farm size. Data are then presented on how land is occupied by various tenure groups, that is, by owners, owners with administrators, tenants, and squatters. Problems of definition and tabulation prevented many significant comparisons that might have been made. However, a salient fact which does emerge from this section is the amount of land managed by administrators. Almost two-thirds of all the land in farms of 1,000 hectares or more is operated by administrators. It can be concluded, therefore, that this land, which comprises a large share of the total available, is in the hands of absentee landlords. It is also estimated that only about 35 percent of all families who are dependent on agriculture are owner-operators, leaving almost

two-thirds of all families dependent on agriculture "in the precarious condition of farm laborers."

Having presented these basic data, Professor Smith then discusses in the remaining chapters (4 through 10) land division, land surveys and land titles, systems of agriculture, agrarian reform, patterns of settlement, community development, and finally social stratification and the class structure. Interspersed throughout the book is comprehensive social, economic, and legal historical background. An interesting academic point, contrary to what has been suggested by some, is that Professor Smith found no evidence, after examining the records of "dozens" of *haciendas*, that any of these were originally *encomiendas*. He holds that the Spanish Crown avoided the simultaneous granting of land and labor in order to prevent indigenous people from falling into a state of perpetual serfdom on the large estates.

Also interspersed throughout the book are copious field notes taken during Professor Smith's many visits to the Colombian countryside. In fact, the case study method is used to substantiate many of the statements made in the book. None of the statements or propositions presented are unreasonable, but they would be more forceful if they were backed with more empirical data. The case-study material may be further criticized on the grounds that it may be outdated. For example, some of the field notes were taken in the 1940's, and the reader cannot help but wonder whether the situation has now changed. Finally, I would like to have seen more comparisons between the 1960 census data and those presented in the censuses of 1938 and 1951, although I realize that the data in some cases may not have been easily comparable.

"A green revolution" is the term which some are using to describe what is happening to agriculture in less-developed countries of Asia. Professor Smith's book is strong evidence that a green revolution in Colombia likely will not be successful unless it is accompanied by social evolution. He predicts that if "substantial reforms are not forthcoming, a huge and violent eruption of the lower social classes is almost sure to ensue; and if this comes about the fact that many of the elite may have deserved no better will be slight solace for the rivers of blood that will flow and the vast destruction of property that will take place" [p. 133].

This is in effect the overall and perhaps oversimplified conclusion of Professor Smith's book: Much has been done, mainly in the way of unplanned or ad hoc reforms. But a great deal more must be done to assist the large number of rural laborers and small farmers if the country is to remain politically stable and socially and economically viable. The economists and sociologists who have advocated structural reforms in rural areas of Latin America will find new material in this book to reinforce their arguments. It is therefore highly recommended to them as well as to those who have propounded schemes of development which would side-step social reform in the rural areas and base agriculture on large-scale mechanized units. Professor Smith promises at a later date two additional volumes on demographic aspects of Colombian society and the basic nucleated social institutions.

L. HARLAN DAVIS
Agency for International Development
Bureau for Latin America

Books for listing in this section should be sent to the Book Review Editor (see inside front cover for address).

Books Received

- Ball, Joyce, ed., *Foreign Statistical Documents*, Stanford, The Hoover Institution on War, Revolution, and Peace, 1967, vii + 173 pp. \$5.00.
- Banco de la Republica, *Indice Economico, diciembre de 1965*, Bogota, Colombia, 1967, vi + 243 pp. Price unknown.
- Buchanan, James M., *The Demand and Supply of Public Goods*, Chicago, Rand McNally & Co., 1968, ix + 214 pp. \$5.00.
- Burk, Marguerite, *Consumption Economics: A Multidisciplinary Approach*, New York, John Wiley & Sons, Inc., 1968, xvii + 359 pp. \$9.95.
- Collins, Norman R., and Lee E. Preston, *Concentration and Price-Cost Margins in Manufacturing Industries*, Berkeley, University of California Press, 1968, xvi + 163 pp. \$5.75.
- Dillon, John L., and G. C. McFarlane, *An Australasian Bibliography of Agricultural Economics, 1788-1960*, New South Wales, Department of Agriculture, 1967, 433 pp. \$6.00.
- Doll, John P., V. J. Rhodes, and J. G. West, *Economics of Agricultural Production, Markets, and Policy*, Homewood, Ill., Richard D. Irwin, Inc., 1968, xiii + 557 pp. \$8.50.
- Dubov, Irving, ed., *Contemporary Agricultural Marketing*, Knoxville, The University of Tennessee Press, 1968, x + 270 pp. \$5.95.
- Ekola, Giles C., *The Christian Encounters Town and Country America*, St. Louis, Concordia Publishing House, 1967, 123 pp. \$1.25.
- El-Kammash, Magdi M., *Economic Development and Planning in Egypt*, New York, Frederick A. Praeger, Publishers, 1968, xxvi + 408 pp. \$15.00.
- Fliegel, Fredrick C., Prodipto Roy, Lalit K. Sen, and Joseph E. Kivlin, *Agricultural Innovations in Indian Villages*, Hyderabad, National Institute of Community Development, 1968, ii + 119 pp. Rs. 12/- \$4.00.
- Freeman, Orville L., *World Without Hunger*, New York, Frederick A. Praeger, Publishers, 1968, xv + 190 pp. \$5.95.

- Gray, James R., *Ranch Economics*, Ames, Iowa State University Press, 1968, viii + 534 pp. \$15.95.
- Helleiner, G. K., ed., *Agricultural Planning in East Africa*, Nairobi, Kenya, East African Publishing House, Ltd., distributed in U.S.A. by Northwestern University Press, 1968, vi + 183 pp. Price unknown.
- Higgins, Benjamin, *Economic Development*, rev. ed., New York, W. W. Norton & Co., Inc., 1968, xvi + 918 pp. \$8.95.
- Imperial Ethiopian Government Ministry of Land Reform and Administration, *Report on Land Tenure Survey of Shoa Province, Arussi Province, Wollega Province, Tabor Wereda (Sidamo), and Gemu Gofa Province*, Addis Ababa, The Department of Land Tenure, 1967 & 1968, 260 pp. \$2.50 each.
- Jensen, R. C., ed., *Proceedings of a New Zealand Seminar on Project Evaluation in Agriculture & Related Fields*, New Zealand, Lincoln College (University of Canterbury), 1968, vi + 196 pp. Price unknown.
- Plate, Roderich, *Agrarmarktpolitik, Band 1: Grundlagen*, Bayerischer Landwirtschaftsverlag Munchen Basel Wien, 1968, xiv + 213 pp. Price unknown.
- Proceedings of a Symposium on Price Effects of Speculation in Organized Commodity Markets, Stanford Food Research Institute, Stanford University, 1967, 194 pp. \$4.00.
- Ruthenberg, Hans, *African Agricultural Production Development Policy in Kenya, 1952-1965*, Munich, Ifo-Institute for Economic Research, African Studies Centre, Vol. 10, New York, Springer-Verlag, 1966, xv + 164 pp. Price unknown.
- Ruthenberg, Hans, *Agricultural Development in Tanganyika*, Munich, Ifo-Institut für Economic Research, African Studies Centre, Vol. 2, New York, Springer-Verlag, 1964, xiv + 212 pp. Price unknown.
- Ruthenberg, Hans, ed., *Smallholder Farming and Smallholder Development in Tanzania*, Munich, Ifo-Institute for Economic Research, African Studies Centre, Vol. 24, München, Weltforum Verlag, 1968, 360 pp. Price unknown.
- Sahota, Gian S., *Fertilizer in Economic Development: An Econometric Analysis*, New York, Frederick A. Praeger, Publishers, 1968, xxii + 240 pp. \$15.00.
- Schickele, Rainer, *Agrarian Revolution and Economic Progress: A Primer for Development*, New York, Frederick A. Praeger, Inc., 1968, xix + 410 pp. \$15.00.
- Schmid, A. Allan, *Converting Land from Rural to Urban Uses*, Baltimore, The Johns Hopkins Press for Resources for the Future, Inc., 1968, xiii + 103 pp. \$4.00.
- Shariff, Ismail, *The Development of Indian and American Agriculture - A Comparative Study*, Danville, Ill., The Interstate Printers and Publishers, Inc., 1968, xviii + 240 pp. \$5.00.
- Strategy for the Conquest of Hunger: Proceedings of a Symposium*, New York, The Rockefeller Foundation, 1968, vii + 131 pp. Price unknown.
- Yamene, Taro, *Mathematics for Economists: An Elementary Survey*, 2d ed., Englewood Cliffs, N.J., Prentice-Hall, Inc., 1968, xvii + 714 pp. \$10.75.
- Yotopoulos, Pan A., ed., *Economic Analysis and Economic Policy*, Training Seminar Series 6, Athens, Center of Planning and Economic Research, 1966, 205 pp. Price unknown.

Announcements

WINTER MEETING AMERICAN AGRICULTURAL ECONOMICS ASSOCIATION WITH ALLIED SOCIAL SCIENCE ASSOCIATIONS

SATURDAY, DECEMBER 28

DECEMBER 28-30, 1968, PICK CONGRESS HOTEL, CHICAGO, ILLINOIS

8:30 a.m. **The Supply Function in Agriculture, Revisited (Joint Session
AEA and AAEA)**

Chairman: GLENN L. JOHNSON, Michigan State University

*Positivistic Measures of Aggregate Supply Elasticities: Some New
Approaches:* LUTHER TWEEEN AND LEROY QUANCE, Oklahoma
State University

*The Representative Farm Approach to Estimation of Supply
Response:* JERRY A. SHARPLES, Economic Research Service,
U.S. Department of Agriculture

Discussants:

JAMES H. WHITE, University of Arkansas

MARVIN W. KOTTKE, University of Connecticut

W. NEILL SCHALLER, Economic Research Service, U.S. De-
partment of Agriculture

2:30 p.m. **The Potential Role of Control Theory in Policy Formulation
for the U. S. Agricultural Industry (Joint Session ES and
AAEA)**

Chairman: KARL A. FOX, Iowa State University

What Does Control Theory Have to Offer? GERHARD TINTNER,
University of Southern California

Methods and Problems in Operational Models: OSCAR R. BURT,
Montana State University

Discussants:

RUSSELL G. THOMPSON, Texas A & M University

FREDERICK V. WAUGH, U.S. Department of the Interior and
the University of Maryland

SUNDAY, DECEMBER 29

- 2:00 p.m. **Technology, Demography, and U. S. Rural Economic Policy**
 Chairman: VERNON W. RUTTAN, University of Minnesota
Demographic and Social Dimensions of Rural Economic Policy:
 CALVIN L. BEALE, Economic Research Service, U.S. Department of Agriculture
Economic Dimensions of Rural Economic Policy: E. J. R. BOOTH,
 University of Connecticut
 Discussants:
 BENJAMIN CHINITZ, Brown University
 LEE R. MARTIN, University of Minnesota

MONDAY, DECEMBER 30

- 9:00 a.m. **Agribusiness and Other Agricultural Economists: Complementary, Supplementary, or Competitive?**
 Chairman: LEONARD J. HAVERKAMP, Wilson and Company
What Agribusiness Economists Need from Theoretical and Empirical Agricultural Economics: A. C. HOFFMAN, Kraft Foods
What Agribusiness Economists Can Contribute to the Content and Equipment of Agricultural Economics: PATRICK J. LUBY, Oscar Mayer and Company
 Discussants:
 CHARLES E. FRENCH, Purdue University
 DALE E. BUTZ, Illinois Agricultural Association
- 12:15 p.m. **Luncheon—AAEA**
 Chairman: W. E. HAMILTON, American Farm Bureau Federation
The Contribution of Foundations to Agricultural Economics:
 JOSEPH ACKERMAN, Farm Foundation

NOMINATING COMMITTEE, 1969-70 AAEA OFFICERS

In accordance with Article VII of the constitution, with the concurrence of the Executive Board, I have appointed the following persons as members of a committee to nominate persons to fill vacancies in offices of the Association for the year beginning August 1969.

Any member of the Association is eligible, and is invited, to submit suggestions as to nominees to Dr. Bishop as chairman, or to other members of the committee. Dr. Bishop's address is Vice President, University of North Carolina, P.O. Box 269, Chapel Hill, North Carolina 27514.

C. E. BISHOP, *ex officio, chairman*
 J. CARROLL BOTTUM
 C. DEL MAR KEARL
 JAMES NIELSON
 HARRY C. TRELOGAN

HAROLD F. BREIMYER
President

**AAEA DISTINGUISHED UNDERGRADUATE TEACHER
AWARD FOR 1969**

To recognize and encourage meritorious performance in undergraduate teaching in agricultural economics, an award of \$250 is provided for presentation by the American Agricultural Economics Association upon recommendation of the selection committee. Nominations for this award may be made by an individual, a group of colleagues, or a department of agricultural economics by the submission of supporting materials according to the rules for this program. Renomination is invited if the materials are brought up to date and resubmitted.

Eligibility for Nomination

The nominee must

1. be actively engaged in teaching during the school year in which the nomination is filed with the selection committee and have been actively engaged in teaching for not less than five years;
2. have demonstrated outstanding ability as an undergraduate teacher of agricultural economics subject matter.

Basis of Selection

The award will be made on the basis of

1. the nominee's ability to motivate and stimulate students;
2. the impression he has made upon his students by the mastery of his subject, his technique, his vision, and his attitudes;
3. evidence of his interest in the improvement of teaching through publication and participation in professional meetings directed toward improved teaching;
4. contribution to undergraduate education outside of the classroom through counseling, student placement, advice to the departmental student club, and similar activities;
5. service to the undergraduate program of the educational institution through extracurricular activities other than those included above, such as membership on college committees, teaching improvement efforts, and faculty leadership roles.

Materials to Be Supplied by the Nominator

1. Six copies of a biography of the nominee, not to exceed 1000 words.
2. Six copies each of letters in support of the nominee from not more than five former students.
3. Letters from at least one representative of the nominee's institution regarding the nominee's activities in the area defined in points 3, 4, and 5 under "Basis for Selection."
4. Six copies of a list of materials developed and/or published by the nominee related to undergraduate instruction. The list may cite the development of items useful in teaching, such as course outlines, curricula, books, research reports, visual aids, charts, models, or other contributions.

Nominations

1. It is desirable to make nominations without the knowledge of the nominee when this does not interfere with submitting a complete file of supporting letters, materials, and a biography. A nomination with supporting materials may be submitted by another individual, a group of colleagues, or a department. Anyone submitting a nominee from another institution will be referred to the department head of that institution for a coordination of efforts, if found to be agreeable to the two parties involved.

2. Six copies of all supporting materials are to be in the hands of the chairman of the selection committee by April 1, 1969.

3. The selection committee for the Teachers Award will consist of six persons, either present or former undergraduate teachers, appointed for staggered terms, and must not include anyone nominated for the award. All members of the selection committee participate in the judging. The selection committee is empowered to recommend that no award be made if, in their judgment, none of the nominees is worthy of the award.

4. *Nominations with supporting materials for the Teacher Award should be sent by April 1, 1969, directly to the chairman of this committee, Tyrus Timm, Department of Agricultural Economics and Sociology, Texas A&M University, College Station, Texas 77843.*

AAEA DISTINGUISHED EXTENSION PROGRAM AWARD FOR 1969

To encourage the development of excellence in Extension economics work, the American Agricultural Economics Association will offer an award of \$250 in 1968. The award will be known as the Distinguished Extension Program Award. Nominations for the award may be made by any member of the American Agricultural Economics Association and selection will be made from among those nominated. An individual may be nominated or two or more individuals may be nominated jointly. It should be noted that the purpose of the award is to recognize an outstanding program achievement and not to recognize an individual or individuals for noteworthy service as Extension economists over an extended period of time.

Each nomination must be made by separate letter to the Extension Award Selection Committee by April 1, 1969, accompanied by four copies of documentary evidence of the achievement of the person or persons nominated. Documentary evidence of the achievement of the person or persons nominated should include an adequate presentation of the following points, in this order: (1) name(s) and title(s) of the person or persons nominated, (2) the problem about which the person or persons nominated built their Extension program and the objectives of the program, (3) clientele served, (4) the program developed to attain the objective(s), including analytical tools and techniques and education methods and procedures used, and (5) program accomplishments in terms of clientele response and/or establishment of the validity of an Extension technique. If two or more persons are nominated jointly, the specific contribution of each to the Extension program must be documented.

In order to be eligible for nomination, an individual or individuals must have had primary responsibility for the Extension program which supports the nomination. The program must have been active within one year of the date of nomination, and its subject matter content must be principally in the field of economics.

Each nomination will be evaluated on the quality of the program which supports the nomination, using the documentary evidence submitted with the nomination as the sole basis for making this evaluation. Equal weight will be given each of the following five characteristics of the program:

1. Its effectiveness as a catalyst to other Extension economists in embarking on new programs or in applying new concepts to existing programs.
2. Its contribution to greater proficiency of Extension personnel in economics programs.
3. Its effectiveness in bringing about a significant change in behavior and/or understanding of the clientele.
4. Originality in recognizing educational opportunities which lend themselves to solution by an Extension economics program.
5. Originality in the application of economic principles and tools of analysis to problem-solving situations in Extension.

Material should be sent to the chairman of this committee, Glen C. Pulver, Division of Human Resource Development, University of Wisconsin, 432 North Lake Street, Madison, Wisconsin 53706.

AAEA AWARDS FOR RESEARCH IN AGRICULTURAL ECONOMICS FOR 1969

To recognize and encourage meritorious research in agricultural economics, ten awards will be offered in 1968 by the American Agricultural Economics Association. Seven awards will be \$250 each and three \$100 each.

Selection for the awards will be made from published research, doctoral theses, master's theses, and articles in the *American Journal of Agriculture Economics* under the procedures outlined below. No one may receive more than one award in any one year, nor an award in the same category more than once every three years. No publication shall be eligible for an award if its substantive equivalent has received an award in any category in an earlier year. All materials submitted should be in English or accompanied by an English translation.

Awards for Published Research

1. Three \$250 awards are offered for outstanding research publications in agricultural economics. These may include bulletins, articles, pamphlets, and monographs, but not textbooks. Joint authors of a winning report will receive proportionate shares of an award so far as eligible.
2. Submissions are invited from areas such as farm management, marketing, prices, cooperation, finance, policy, theory, methodology, rural development, farm population, foreign agriculture, land and water economics, conservation, regional adjustment, international trade, economic history, state and local gov-

ernment, that throw significant light on the agricultural economy. Entries will be judged as a group rather than in particular areas.

3. Selections will be made from published research bearing a publication date in 1968.

4. Eligible recipients must be under 41 years of age at the time of publication, but may have older joint authors.

5. Any paper authored or co-authored by a member of this awards subcommittee will be ineligible.

6. No penalty for joint authorship will be imposed unless one or more authors are over 41.

7. Each published report may receive only one award presented by the American Agricultural Economics Association in 1969. However, a report may be entered in more than one of the following categories: (a) Best article in the *American Journal of Agricultural Economics*; (b) Published research; (c) Doctoral thesis; and (d) Master's thesis.

8. Thirteen copies of each publication should be submitted for consideration, unless expense to the individual is excessive.

9. The Awards subcommittee for published research consists of 12 persons, in addition to the chairman, representing various fields. The members of the subcommittee will serve as voting judges, except the chairman, who will vote only in the event of a tie. The chairman of this subcommittee is G. Edward Schuh, Department of Agricultural Economics, Purdue University, West Lafayette, Indiana 47901.

10. Publications should be sent directly to the *chairman of this subcommittee before March 16, 1969.*

Awards for Doctoral Theses

1. Three \$250 awards will be available for theses prepared by candidates for the doctoral degree in any department engaged in training agricultural economists at the doctoral level.

An entry must be submitted by the head of the department where the thesis was presented in partial fulfillment of requirements for a degree. A department may submit one thesis for each eight doctoral theses or fraction thereof presented, in agricultural economics, to a graduate school faculty in the year.

3. Selection will be made from theses approved in final form by the student's advisory committee during the calendar year 1968, provided the candidate has met all other formal requirements for the doctoral degree.

4. A published thesis may be entered in both the published research and thesis classes but will be eligible for only one award. Although a published thesis is acceptable, a copy of the thesis as submitted to the graduate faculty should be sent whenever possible.

5. Two copies of a thesis must be sent to the subcommittee chairman. All copies will be returned after they have been read by the judges.

6. The awards subcommittee for doctoral theses will consist of six persons, in addition to the chairman. All members of the subcommittee will serve as voting judges, except the chairman, who will vote only in the event of a tie. The chair-

man of this subcommittee is Carl K. Eisher, Department of Agricultural Economics, Michigan State University, East Lansing, Michigan 48823.

7. Theses should be sent directly to the *chairman of this subcommittee before March 16, 1969.*

Awards for Master's Theses

1. Three \$100 awards will be available for theses prepared by candidates for the master's degree in any department engaged in training agricultural economists at the master's degree level.

2. An entry must be submitted by the head of the department where the thesis was submitted in partial fulfillment of requirements for a degree. A department may submit one thesis for each eight master's theses or fraction thereof presented, in agricultural economics, to a graduate school faculty in the year.

3. Selection will be made from theses approved in final form by the student's advisory committee during the calendar year 1968 provided the candidate has met all other formal requirements for the master's degree.

4. Two copies of a thesis must be sent to the subcommittee chairman. All copies will be returned after the committee has completed its work.

5. A published thesis may be entered in both the published research and thesis classes but will be eligible for only one award. Although a published thesis is acceptable, a copy of the thesis as submitted to the graduate faculty should be sent whenever possible.

6. The awards subcommittee for master's theses will consist of six persons in addition to the chairman. All members of the subcommittee will serve as voting judges, except the chairman, who will vote only in the event of a tie. The chairman of this subcommittee is Paul E. Nelson, Jr., Marketing Economics Division, ERS, USDA, Washington, D.C. 20250.

7. Theses should be sent directly to the *chairman of this subcommittee before March 16, 1969.*

Award for Best Article in the *American Journal of Agricultural Economics*

As has been the practice for a number of years, the editorial staff and the editorial council of the *American Journal of Agricultural Economics*, with the editor as chairman, will choose the most outstanding article published in the *Journal* during the preceding calendar year (in this instance 1968). The amount of this award is \$250.

Announcements of the 1969 awards will be made at the 1969 annual meeting of the American Agricultural Economics Association. Names of the recipients of the 1968 awards will appear in the 1968 proceedings issue of the *American Journal of Agricultural Economics*.

These awards are financed in part from funds donated by persons and firms interested in advancing research and scholarship in agricultural economics. The funds and programs are administered by the American Agricultural Economics Association. General inquiries and requests for additional copies of this announcement should be sent to the chairman of the Awards committee, Emery N. Castle, Department of Agricultural Economics, Oregon State University, Corvallis, Oregon 97331.

BACK ISSUES OF JOURNAL OF FARM ECONOMICS NEEDED

The secretary-treasurer of the AAEA is authorized to pay \$1.00 each for any of the issues of the *JFE* listed below.

<i>Year</i>	<i>Volume</i>	<i>Issues</i>	<i>Year</i>	<i>Volume</i>	<i>Issues</i>
1919	1	1, 2, 3	1951	33	1, 3
1920	2	1, 2, 3, 4	1952	35	1, 5
1921	3	1, 2, 3, 4	1954	36	2, 3
1922	4	1, 2, 3, 4	1955	37	1, 2, 3, 4, 5
1923	5	1, 2	1956	38	1, 2, 3, 5
1924	6	1, 2, 3, I	1957	39	2
1925	7	1, 2, 4, I	1958	40	2
1926	8	1, 2, 3, 4, I	1959	41	1, 3
1935	17	1	1960	42	1, 4, 5
1943	25	1, 2, 3, 4	1961	43	2, 3, 4-2
1944	26	2, 3	1962	44	1
1945	27	1, 2, 3, 4	1963	45	1, 4, 5
1946	28	1, 2, 3	1964	46	2, 3, 5
1947	29	1, 2	1965	47	1
1948	30	1	1967	49	1-1, 1-2

Journals should be mailed to C. Del Mar Kearn, AAEA, Department of Agricultural Economics, 455 Warren Hall, Cornell University, Ithaca, New York 14850.

EAST AFRICAN JOURNAL OF RURAL DEVELOPMENT

A new journal, *The East African Journal of Rural Development*, has recently been issued by the East African Agricultural Economics Society and the Department of Rural Economy and Extension of Makerere University College. The journal is the first in the field of agricultural economics to be published in sub-Saharan Africa and will appear twice a year. Although the primary focus of the journal is eastern Africa, it will contain articles concerned with the economics of food and agriculture throughout the developing world.

Persons or institutions in the United States desiring a complimentary copy of the initial issue should address:

Professor Thomas T. Poleman
Department of Agricultural Economics
Cornell University
Ithaca, New York 14850

From elsewhere apply to:

The Editor
East African Journal of Rural Development
Makerere University College
P.O. Box 7062
Kampala, Uganda

News Notes

PERSONAL

Rufus Adegbeye, senior lecturer at the University of Ibadan in Nigeria, is spending three months studying land tenure processes in the Department of Agricultural Economics at the University of Wisconsin. He will spend an additional three months visiting departments at Iowa State, California (Davis), Tuskegee, North Carolina, and the USAD in Washington.

Osama Al-Zand, who is completing his Ph.D. degree at the University of Minnesota, has accepted a two-year assignment on the Minnesota-Tunisia project, where he will be working in the general areas of marketing, price analysis, and commodity policy under a contract with the University of Minnesota and AID. His assignment in Tunisia will begin after he completes his Ph.D. thesis during the fall quarter.

Philip T. Allen, Farm Production Economics Division, ERS, USDA, Washington, D.C., has transferred to AID for a two-year tour of duty in Liberia, where he will be Food and Agriculture Officer for the AID Mission stationed in Monrovia.

Gill Amjad has transferred from Foreign Agricultural Service, USDA, to a position in Long Range Outlook, Far East Branch, Foreign Regional Analysis Division, ERS, USDA.

Jerome V. Bambenek has completed his M.S. degree at the University of Minnesota and has accepted employment at the Federal Intermediate Credit Bank of St. Paul, Minnesota.

James C. Barron has finished his Ph.D. degree at Pennsylvania State University and has joined the faculty of the Agricultural Economics Department at Washington State University. He will do extension and research in resource development, with emphasis on development problems in the rapidly urbanizing and industrializing area of western Washington.

Calvin L. Beale, Economic Research Service, USDA, received the Distinguished Service Award at the Honor Award Ceremony on May 14, 1967.

Roscoe E. Bell, formerly director of the Alaska Division of Lands, is lecturer in the Department of Agricultural Economics at the University of Wisconsin and consultant to the University's study of federal land law in Alaska for the Public Land Law Review Commission.

Arlo Biecr, who recently completed his Ph.D. at the University of California, Berkeley, is now on the staff of the Department of Agricultural Economics at Kansas State University.

Charles Edwin Bishop, vice-president of the public service programs at the University of North Carolina, received the honorary degree of Doctor of Laws at Berea College on June 3, 1968.

Gordon E. Bivens has joined the faculty of the University of Missouri as professor of family economics and agricultural economics. During 1967-68, he served as consumption economist with the Consumer and Food Economics Research Division, ARS, USDA, Washington, D.C., while on leave as professor of economics, University of Wisconsin, Milwaukee. At Wisconsin, he had also served as director of the Center for Consumer Affairs, University Extension, and as chairman of the Department of Economics, University Center System.

Harvey M. Bjerke has been appointed farm management extension agent for the Southeast Minnesota Farm Management Association, West Concord.

J. Roy Black has completed his Ph.D. degree at the University of Minnesota and has accepted a position with the Rockefeller Foundation. He will be stationed at New Delhi, India.

Thomas A. Brewer, who is completing his Ph.D. at Cornell University, will join the faculty in the Department of Agricultural Economics at Washington State University. He will do extension, teaching, and research in agribusiness management.

David W. Brown, formerly visiting professor at Iowa State University, accepted an appointment as international professor of agricultural economics in the Department of Agricultural Economics and Rural Sociology at the University of Tennessee, effective July 1, 1968.

Dr. Brown's position was established as a result of the Department's receiving a \$200,000 institutional grant from the Agency for International Development to strengthen research and teaching relating to international agriculture.

Joseph D. Brown, University of Georgia, has resigned to accept a position as associate professor of marketing, College of Business, Ball State University, effective September 1968.

George Bullion has joined the staff of the Marketing Economics Division, ERS, USDA, in Lafayette, Indiana.

E. L. Butz, Purdue University, has rejoined the staff in the dual capacity of dean of continuing education and vice president of the Purdue Research Foundation.

Carlos H. Caraballo, M.S. Michigan State University, has been appointed assistant to the president of the Midwestern Region Development Foundation in Venezuela. He is also doing teaching in economics and farm management at Mid West University, Venezuela.

Ju Chun Chai joined the Long Run Projections Section, Outlook and Projections Branch, Economic and Statistical Analysis Division, ERS, USDA, on August 16, 1968. Formerly he was with the Department of Economics, University of Georgia.

Alain Choppin de Janvry, assistant professor, Department of Agricultural Economics, University of California, Berkeley, has an appointment in Buenos Aires, Argentina, for two years, commencing October 1, 1968. He will serve as a project specialist with the Ford Foundation's project in agricultural economics in Argentina.

Robert Christensen will join the Department of Agricultural and Food

Economics at the University of Massachusetts on September 1, 1968, as an associate professor. He will teach and work in extension farm management and production economics. Dr. Christensen was previously assistant professor in the Department of Resource Economics at the University of New Hampshire.

Lawrence M. Christenson has accepted a position in area farm management extension at Waseca, Minnesota. This is one of several newly created positions in the Department of Agricultural Economics and the Agricultural Extension Service at the University of Minnesota.

Norman R. Collins, professor in the Department of Agricultural Economics, University of California, Berkeley, has an appointment in Chile as the Ford Foundation agricultural program advisor at the University of Chile. The appointment is for an 18-month period, beginning January 1, 1969.

Arthur G. Conover returned on May 13, 1968, to the Economic and Statistical Analysis Division, ERS, USDA, from optional retirement. He is serving in the Office of the Director.

Hugh L. Cook, Department of Agricultural Economics, University of Wisconsin, has returned from the Irish Republic, where he spent four months early this year as consultant for the Irish Department of Agriculture and Fisheries. His report (with Gordon W. Sprague) recommending a national reorganization of the cooperative creamery industry is in process of publication.

Gail Cramer, who obtained his Ph.D. degree at Oregon State University last June and is presently assistant professor of agricultural economics

at Montana State University, has won the \$1,000 Nourse award given by the American Institute of Cooperation. His Ph.D. thesis was selected as being the outstanding entry in the Ph.D. thesis competition sponsored by the Institute. Dr. Leon Garoian served as major professor for Dr. Cramer.

Carlton G. Davis, Ph.D. candidate at Michigan State University, will spend the 1968-69 year at the University of the West Indies, St. Augustine, doing research for his thesis.

John P. Doll, on sabbatical leave from the University of Missouri during the past year, has returned to Columbia after spending the summer with the Branch of Economics Research, Division of Economics, Bureau of Commercial Fisheries, College Park, Maryland. Formerly on a joint appointment between economics and agricultural economics, Doll has accepted a full-time appointment as professor of economics and will teach econometrics and mathematical economics.

John H. Droge has completed the requirements for his Ph.D. degree in agricultural economics at the University of Wisconsin and will continue to do research in fruit and vegetable processing for the Horticultural and Special Crops Branch, Marketing Economics Division, ERS, USDA, in Madison, Wisconsin.

S. B. Dooley has completed his M.S. at Purdue University and is continuing for the Ph.D. at Purdue.

W. David Downey, Purdue University, has won the Outstanding Teacher in Agriculture Award, by student vote, on that campus.

Alfred Eckert, assistant professor of agricultural economics at the Uni-

versity of Nebraska, retired July 1, 1968.

Robert H. Elrod joined the Marketing Economics Division, ERS, USDA, at Clemson, South Carolina, for research related to the textile industry. He is a candidate for the Ph.D. at Clemson University.

N. Eugene Engel will be serving as acting head of the Department of Agricultural and Food Economics at the University of Massachusetts during the academic year of 1968-69. Dr. Engel recently completed his Ph.D. at the University of Connecticut. He is an associate professor in teaching and extension in community resource development.

Robert V. Enochian, MED, ERS, has been detailed to the State Department for a three-month assignment. Mr. Enochian will be responsible for preparing an appraisal of the agricultural potentials of the Caribbean Islands which will be one part of an overall study of the economies of these islands.

Robert Forste will join the Department of Agricultural and Food Economics at the University of Massachusetts on July 1, 1968. Mr. Forste will teach and do research in the area of resource economics. He was previously instructor in the Department of Resource Economics at the University of New Hampshire.

Earl R. Franklin has resigned from his position as extension marketing specialist at Washington State University to become chief of the Drainage and Irrigation Branch, U.S. Census, Washington, D.C.

Mervin L. Freeman has accepted a position in area farm management extension at Rochester, Minnesota. This is one of several newly created positions in the Department of Ag-

ricultural Economics and the Agricultural Extension Service at the University of Minnesota.

William R. Gasser has taken over as chief of the Western Hemisphere Branch, Foreign Regional Analysis Division, ERS, USDA.

Ray Geisman left the Economic Development Division, ERS, USDA, to accept a job with a Dallas, Texas, organization, "Goals for Dallas." He will hold an associate professorship at Southern Methodist University in the Institute of Urban Studies.

Brian G. Gnauck has completed his Ph.D. degree at the University of Minnesota and returns to active duty in the United States Air Force in September 1968.

Donald R. Gratehouse, Farm Production Economics Division, ERS, USDA, Washington, D.C., has transferred to the Department of Housing and Urban Development.

Wade F. Gregory, Foreign Development and Trade Division, ERS, USDA, has accepted a two-year assignment in Colombia as team leader of a USDA/AID Technical Research and Planning Team to advise the minister of agriculture on agricultural development planning.

Mark Gustafson received his M.S. degree in June 1968 from the Agricultural Economics Department at the University of Nebraska and is presently working on his Ph.D. at the University of California at Berkeley.

Teferra Hailu received his M.S. degree in June 1968 from the Agricultural Economics Department at the University of Nebraska and has returned to Harrar, Ethiopia, and is presently employed with the government of his country.

Richard Hall has returned to the United States from Bolivia, where he served as technical adviser in marketing for the past two years. He is returning to the Marketing Economics Division, ERS, USDA, to resume his work in marketing.

Albert N. Halter has returned to the Department of Agricultural Economics at Oregon State University after a year's sabbatical leave spent in the Department of Economics at Stanford University.

Thomas E. Hamilton, economist with the Pacific Northwest Forest Experiment Station, U.S. Forest Service, is visiting professor at Wisconsin for the summer of 1968, teaching a course in land economics.

Albert H. Harrington, professor of agricultural economics at Washington State University, received the R.M. Wade Award for Excellence in Instruction in the College of Agriculture.

David H. Harrington, Farm Production Economics Division, ERS, USDA, Ithaca, New York, has been reassigned to Lafayette, Indiana, where he will enter on a program of full-time graduate study at Purdue University under the Government Employees Training Act.

Stephen Harsh has accepted a position as assistant professor at Michigan State University after completion of the Ph.D. at Cornell University. His work will be in the area of farm management research and extension.

Peter Helmberger, formerly at the University of Wisconsin, has been appointed associate professor of agricultural economics at the University of California, Berkeley.

Jack L. Hervey has resigned from Michigan State University to join

the staff of the Federal Reserve Bank of Chicago. His research will be primarily on international trade.

John M. Himmeberg, a recent graduate of Holy Cross College, joined the Farm Income Estimates Section of the Farm Income Branch, Economic and Statistical Analysis Division, ERS, USDA, on July 15, 1968.

John S. Hobson has completed his M.S. at Purdue University and is employed in the Purchasing Department of Procter & Gamble in Cincinnati, Ohio.

Karl Hobson, extension price and outlook specialist in the Department of Agricultural Economics at Washington State University, was awarded the Federal Land Banks Golden Anniversary medal for outstanding contributions to American agriculture.

Thomas K. Hunter received his Ph.D. degree in agricultural economics at the University of Tennessee in June 1968 and returned to the staff of Texas A&M University.

George D. Irwin, Farm Production Economics Division, ERS, USDA, Washington, D.C., has returned to his regular field station in Lafayette, Indiana, after a nine-month special assignment in the Office of the Director.

Jack T. Ishida, University of Hawaii, will be a visiting professor at Purdue University during the first semester 1968-69.

Elmar Jarvesoo, associate professor in the Department of Agricultural and Food Economics at the University of Massachusetts, will be on sabbatical leave to pursue studies of input-output analysis at Harvard University from July 15, 1968, until January 15, 1969.

Allan S. Johnson, staff assistant in the Office of the Administrator, ERS, USDA, has been accepted by the National Institute of Public Affairs and Stanford University as a fellow in the Educational Program in Systematic Analysis for the year 1968-69. Mr. Johnson will return in July 1969.

James Johnson received his M.S. degree in June 1968 from the Agricultural Economics Department at the University of Nebraska and is presently employed as a marketing analyst with Allis-Chalmers in Milwaukee, Wisconsin.

Alexander Joss, secretary of the Federal Land Bank of Spokane, Washington, was named vice-president and secretary, effective August 5, 1968. Dr. Joss came to the Land Bank in 1946 as director of research for the Farm Credit banks.

Robert L. Joss, who recently completed his Ph.D. degree in finance at Stanford University, has been named one of 19 White House Fellows for 1968-69. President Johnson established the White House Fellowship program in 1964 to give young leaders "first-hand, high-level experience of participation in national affairs." The 49 Fellows selected during the first three years of the program have acted as assistants to White House staff members, the Vice-President, and Cabinet officers.

Ronald E. Kaldenberg has completed his Ph.D. degree at the University of Minnesota and has been appointed assistant professor at Bradley University.

Maxwell I. Klayman has resigned from his post as economist with the Food and Agriculture Organization of the United Nations at Rome and has accepted a post starting in Sep-

tember as professor of economics in charge of the Latin American Area Studies Program at the State University of New York College at New Paltz, New York. He will also be a Journal Professor of Economic Development at the State University Center at Albany. He has spent the past year in Washington on leave from FAO as a consultant to the Inter-American Development Bank and is completing a manuscript to be published by the Praeger Press entitled, "The Moshav in Israel: A Case Study in Institution Building for Agricultural Development."

Max R. Langham, on leave from the University of Florida, will be visiting associate professor in the Department of Agricultural Economics, University of Minnesota, for one year beginning September 1, 1968. He will conduct research in cooperation with the Economic Research Service, USDA, on the criteria for measuring performance of the orange industry.

Larry Leistriz received his M.S. degree in July 1968 from the Agricultural Economics Department at the University of Nebraska and is presently working on his Ph.D. degree at Nebraska.

An-Yhi Lin, formerly assistant professor of economics at Wisconsin State University, has joined the faculty of economics at Southern Illinois University as assistant professor.

Percy R. Luney, agricultural economist with the Natural Resource Economics Division, ERS, USDA, has been assigned to the position of staff assistant in the Office of the Administrator.

Michael H. Lynch has resigned his position as farm management extension agent for the Southeast Minnesota Farm Management Association

in Worthington to accept employment with the International Harvester Company.

Donald Marion, assistant professor in the Department of Agricultural and Food Economics at the University of Massachusetts, will be on sabbatic leave during the fall semester of 1968-69 completing his study for his Ph.D. dissertation in the Department of Economics at the University of Massachusetts. He will be studying food distribution costs in low-income areas.

George (Yoshihiro) Maruyama, associate professor at Kyoto University in Japan, has been awarded the Agricultural Economics Society of Japan Award. This award is limited to one recipient per year who has not been in the field more than 15 years since his college graduation. The award is granted on the basis of all the researcher's publications during this period. Dr. Maruyama won the award for "An Integrated Measure for Both Profitability and Stability," published in the *Journal of Rural Economics*, Volume 31, No. 2, September 1959, and 17 other outstanding published research papers. Dr. Maruyama was a research fellow and a visiting associate professor at the University of Massachusetts from 1962 to 1964 and is a member of the American Agricultural Economics Association.

Edmond Missiaen has joined the Africa and Middle East Branch, Foreign Regional Analysis Division, ERS, USDA.

Wesley Musser received his M.S. degree from the Agricultural Economics Department at the University of Nebraska in June 1968 and is presently working on his Ph.D. at the University of California at Berkeley.

David B. Narrie reported for duty on July 1 with the Marketing Economics Division, ERS, USDA, in Blacksburg, Virginia, where he will be evaluating the feasibility of expanded grain storage facilities in the southeast. He completed an M.S. degree at the University of Georgia in June and plans further graduate study at Virginia Polytechnic Institute.

William Neal, M.S. Michigan State University, has joined the Goodyear Company in Akron, Ohio, working in market research.

Ken Nelson has joined the staff of the Marketing Economics Division, ERS, USDA, in Stillwater, Oklahoma.

John W. Nixon, who is completing his Ph.D. in agricultural economics at Michigan State University, has accepted a position as assistant professor of agricultural economics at the University of Georgia. He will do teaching and research in the areas of resource economics and marketing policy.

Carmer O. Nohre, formerly chief of the International Monetary and Trade Research Branch, has been appointed deputy director of the Foreign Development and Trade Division, ERS, USDA.

Jorge Cliviera of the Federal University of Rio Grande do Sul in Brazil spent four months as a visiting fellow in the Department of Agricultural Economics at the University of Wisconsin.

William S. Penning has accepted a position in area farm management extension at Thief River Falls, Minnesota. This is one of several newly created positions in the Department of Agricultural Economics and the Agricultural Extension Service at the University of Minnesota.

Walter H. Pierce retired as professor emeritus from the Department of Economics at North Carolina State University on April 1, 1968.

Russell G. Pounds, an extension associate in the Department of Economics at Iowa State University, will spend eight months beginning June 1, 1968, as director of the Des Moines Model Cities Project, Des Moines, Iowa.

Sydney C. Reagan has been appointed director of the newly established Institute of Urban Studies at Southern Methodist University. He will continue as professor of economics and real estate.

Robert Reed, professor of agricultural economics at the University of Wisconsin, has begun a two-year assignment at the University of Rio Grande do Sul in Brazil.

Philip F. Rice completed his Ph.D. in industrial management at Clemson University in June. He resigned from the Marketing Economics Division Clemson office staff on August 20 to accept a position with Louisiana Polytechnic Institute.

Gordon E. Rodewald, Farm Production Economics Division, ERS, USDA, Urbana, Illinois, has been reassigned to Washington, D.C.

Sargent Russell returned to the Department of Agricultural and Food Economics at the University of Massachusetts on June 10 after serving as a Fulbright lecturer in marketing at Ege University in Izmir, Turkey.

Seymour S. Sackrin, acting head of the Tobacco Section, Commodity Analysis Branch, Economic and Statistical Analysis Division, ERS, USDA, left on March 30, 1968, to go to the United States Tariff Commission.

David A. Schultz has completed his M.S. at Purdue University. He is now working on his Ph.D. at Cornell University.

Wesley D. Seitz, who recently completed his Ph.D. at the University of California, Berkeley, is now on joint appointment to the Department of Marketing and the Department of Agricultural Economics at the University of Illinois.

V. V. Sharma has joined the staff of Purdue University as a post-doctoral fellow for the 1968-69 year. Professor Sharma completed his Ph.D. at the University of Illinois.

Charles N. Shaw, Marketing Economics Division, ERS, USDA, has been reassigned from Washington, D.C., to University Park, Pennsylvania.

J. R. Simmerman has completed his M.S. at Purdue University and is working as vocational agriculture teacher at Spencer Community High School in Spencer, Indiana.

Allen G. Smith, Farm Production Economics Division, ERS, USDA, Urbana, Illinois, has been reassigned to Washington, D.C.

Blair J. Smith received the Ph.D. degree in economics from the North Carolina State University in May 1968. He has left the University of Florida and is now an associate economist in the Department of Agricultural Economics at the University of Georgia.

John H. Southern, director of the Economic Development Division, ERS, represented the Department of Agriculture at the annual International Labor Conference, Geneva, Switzerland, June 2 to 27. The agenda item which involved the USDA was "Improving the Conditions of Work and Life Among Agricultural Workers." About 105 nations were repre-

sented at the conference, with some 67 participating in the committee on which Mr. Southern served.

John T. Steele has joined the U.S. AID-Texas A&M University contract team in Roque Saenz Pena, Argentina.

Henry Stippler, ETS-USDA retired, left Corvallis, Oregon, in July 1968 for a two-year assignment with United Nations in Tripoli, Libya. He will be working with the ministers of agriculture and planning in development of the second five-year plan for that nation.

John G. Stovall, head of the Southern Field Research Group, Farm Production Economics Division, ERS, USDA, Washington, D.C., has returned to Lexington, Kentucky, which will henceforth be his duty station.

Abraham Subotnik, formerly of the Food Research Institute, Stanford University, joined the faculty of the University of Minnesota as research associate in the Department of Agricultural Economics. He is working with James P. Houck, Jr., in the areas of international trade in fats and oils and agricultural price analysis.

Larry V. Summers has completed the requirements for his Ph.D. degree in agricultural economics at the University of Idaho and will continue to do research in fruit and vegetable marketing for the Horticultural and Special Crops Branch, Marketing Economics Division, ERS, USDA, in Moscow, Idaho.

Ernst W. Swanson retired as professor emeritus from the Department of Economics at North Carolina State University on July 1, 1968.

Alexander Swantz, formerly assistant deputy administrator for regulatory

programs in the Consumer and Marketing Service, USDA, has been appointed associate administrator of the Commodity Exchange Authority.

Jorge L. Tersoglio has completed his M.S. at Purdue University and is continuing for the Ph.D. at Purdue.

L. A. Trinidad has completed his Ph.D. at Purdue University and has returned to the Philippines, where he is agricultural economist in the Bureau of Agricultural Economics.

Warren Trotter has been reassigned within the Marketing Economics Division, ERS, USDA, to the Regional Utilization Laboratory Liaison Group. Dr. Trotter will be stationed in Athens, Georgia, where he will serve as liaison economist to the new Southeastern Utilization Research and Development Division, Agricultural Research Service.

Willem Van Vuuren, who recently completed his Ph.D. at the University of California, Berkeley, is now on the faculty of the Department of Economics at the University of Guelph in Ontario, Canada.

Herman J. VanWersch, who is completing his Ph.D. degree at the University of Minnesota, has accepted a two-year assignment on the Minnesota-Tunisia project, where he will be working in the general areas of marketing, price analysis, and commodity policy under a contract with the University of Minnesota and AID. His assignment in Tunisia will begin after he completes his Ph.D. thesis during the fall quarter.

Peter von zur Muehlen, Farm Production Economics Division, ERS, USDA, Washington, D.C., resigned to join the research staff of the Board of Governors, Federal Reserve Board, to work as a member

of a special study group on problems of investment aggregation.

Herbert H. Walch has completed his Ph.D. degree at the University of Minnesota and has been appointed assistant professor at the University of Tennessee.

Richard G. Walsh, professor of agricultural economics at the University of Nebraska, has resigned to accept a position at Colorado State University.

Harry E. Walters has returned to his job as leader of Communist Areas Analysis, Foreign Regional Analysis Division, ERS, USDA, from a year's study at the University of Washington as a National Institute of Public Affairs fellow.

Ronald Ward has joined the staff of the Marketing Economics Division, ERS, USDA, in Ames, Iowa.

Erlin J. Weness has been appointed farm management extension agent for the Southwest Minnesota Farm Management Association, Worthington. He joined the department on July 1, 1968.

D. Clay Whybark has accepted a joint appointment with the Department of Agricultural Economics, Purdue

University, and the School of Industrial Administration. Professor Whybark has completed his Ph.D. at Stanford University and will do teaching and research in production management.

Charles M. Wilson received his Ph.D. Degree in agricultural economics at the University of Tennessee in June 1968 and accepted a position with the Federal Reserve Bank of Dallas, Texas.

J. B. Wyckoff, head of the Department of Agricultural and Food Economics at the University of Massachusetts, will join Resources for the Future in Washington, D.C., for the academic year 1968-69. He will be working with Marion Clawson and George McBride on a study of urban impact on the rural countryside.

Hiroshi Yamauchi, who recently completed his Ph.D. at the University of California, Berkeley, is now on the faculty of the Department of Agricultural Economics at the University of Hawaii.

Harold Yee, a Ph.D. candidate at the University of California, has been reassigned to the Horticultural and Special Crops Branch, Marketing Economics Division, ERS, USDA.

OBITUARIES

Claude F. Clayton, a retiree from the USDA, died on May 10, 1968, in Knoxville, Tennessee, at the age of 78. He began his federal career in the old Division of Land Economics, BAE, USDA. He played a prominent role in the Land Utilization Program of the 1930's and was USDA coordinator with TVA at Knoxville. He retired from government service on February 28, 1955, as an agricultural economist for the U.S. Agency for International Development.

Ralph H. Rogers, 70, who recently re-

tired from the position of agricultural economist with the Farm Production Economics Division, ERS, USDA, at Texas A&M University, died on June 17 in a Houston hospital. He had retired on April 30 after 38 years of service with USDA. Born in Indiana, Mr. Rogers was a veteran of World War I. He received BS and MS degrees in agricultural economics in 1922 and 1924 at Purdue University. He served as research economist and farm management specialist with the South Dakota Experiment Sta-

tion and Extension Service from 1924 to 1929, was research economist with the North Carolina Experiment Station from 1929 to 1934, and joined the USDA as an agricultural economist in 1934. His early USDA years were spent in Wash-

ington, D.C., and Arkansas; in 1947 he went to Texas A&M, where he was active in cooperative research with Texas Agricultural Experiment Station personnel on production economics research projects.

ORGANIZATIONAL

The Awards Committee of the Council on Consumer Information has set a February 1, 1969, deadline for submission of papers to be considered for the 1969 Dissertation Research Award of \$100. The competition is open to graduate students and recent graduates reporting dissertation research on consumer problems completed in 1967 or 1968. Each paper should be prepared in professional journal form and should not exceed 15 double-spaced typed pages in length. The authors of outstanding papers will be invited to present their papers at the annual conference and all papers will be considered for publication in the *Journal of Consumer Affairs*. Entries

should be mailed to the chairman, Dr. Marguerite C. Burk, Department of Agricultural Economics, University of Minnesota, St. Paul 55101. Other members of the Awards Committee are Dr. Mabel Rollins of Cornell University and Dr. Barbara Reagan of Southern Methodist University.

Michigan State University has accepted a grant of \$135,000 for the study of marketing problems in Tanzania. The study will be under the direction of Glenn L. Johnson. Herbert Kreisel and Kenneth Laurent are working on the project in Tanzania. Kreisel will be chief of party.

ADDITIONS TO LIST OF DOCTORAL DEGREES CONFERRED IN 1967

Ahmed Sheik Basheer, B.A. Osmania College, Kurnool, 1954; M.A. University of College Arts, 1957; M.S. Texas A&M University, 1963; Ph.D. Texas A&M University, *Stochastic Investment Problem and Dynamic Truck Replacement Policy*.

Albert B. Krienke, B.S. University of Florida, 1958; M.S. University of Florida, 1961; Ph.D. Texas A&M University, *An Economic Evaluation of the Production Incentives and Payment Methods in Major Texas Fluid Milk Markets*.

Merritt G. LaPlante, B.S. University of Massachusetts, 1958; M.S. University of Massachusetts, 1960;

Ph.D. Texas A&M University, *An Economic Evaluation of Distributor Controlled and Advertised Brands of Fluid Milk on Manufacturer's Advertised Brands*.

Ivan Schmedemann, B.S. Kansas State University, 1953; M.S. Kansas State University, 1957; Ph.D. Texas A&M University, *An Economic Analysis of the Demand for Campsites and Related Facilities in East Texas*.

Edward Uvacek, Jr., B.S. Rutgers University, 1952; M.S. Rutgers University, 1956; Ph.D. Texas A&M University, *An Economic Analysis and Forecasting Model of the Beef Cattle Industry*.

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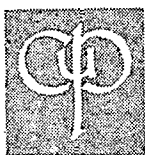
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